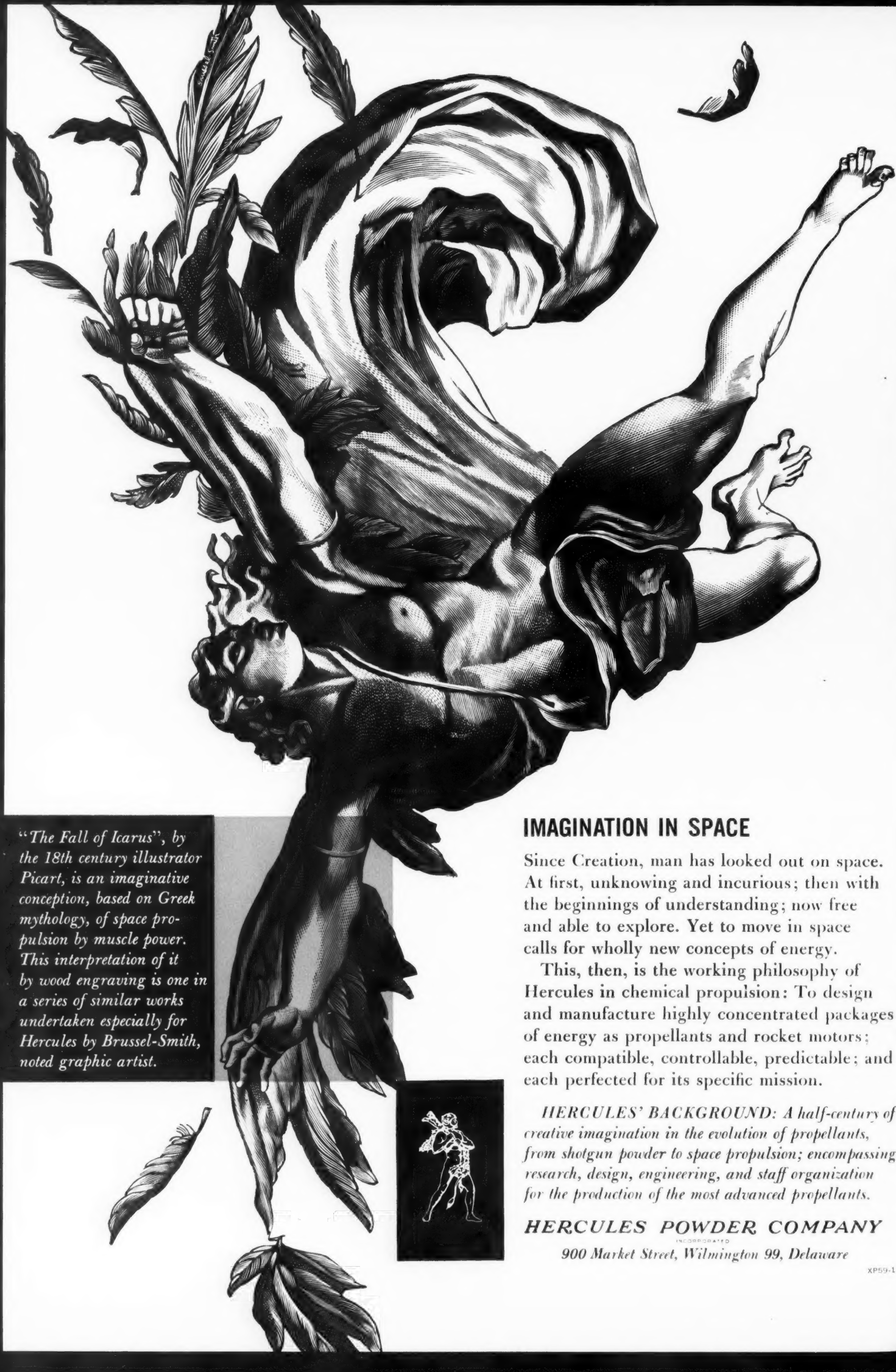
Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY

JANUARY 1960

SPECIAL SECTION ON SOVIET ASTRONAUTICS

10-PAGE ARS ANNUAL MEETING REPORT



"The Fall of Icarus", by the 18th century illustrator Picart, is an imaginative conception, based on Greek mythology, of space propulsion by muscle power. This interpretation of it by wood engraving is one in a series of similar works undertaken especially for Hercules by Brussel-Smith, noted graphic artist.

Astronautics

A PUBLICATION OF THE AMERICAN ROCKET SOCIETY, INC.

January 1960 volume 5 number 1

EDITORIAL

ARS ANNUAL MEETING

SOVIET ASTRONAUTICS

FEATURES

DEPARTMENTS

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Astro notes

MAN IN SPACE

• NASA performed its first successful Project Mercury biological experiment early last month when it rocketed monkey Sam (for School of Aviation Medicine) to an altitude of 55 miles aboard a Little Joe test vehicle and recovered him 2 hr later. The 7-lb rhesus monkey survived his ride in splendid condition; but the Naval task force (two destroyers and two other vessels) had rough going in the heavy seas before Sam was safely deposited at Norfolk, Va., for a flight back to Brooks AFB, Tex.

• McDonnell's capsule program for Project Mercury now provides for some 20 capsules with a total value of $40 million, including 8 capsules earmarked for Redstone, 8 for Atlas, 1 for static test, and 1 to remain at McDonnell. First suborbital try with the McDonnell capsule aboard the Redstone rocket is expected about May. At the same time, NASA plans an Atlas-Big Joe shot to certify the capsule on a maximum-performance trajectory and a second Atlas shot to place a chimpanzee in orbit for three passes before recovery. The first astronaut flight in a Redstone could be made by midsummer if orientation, control, and other capsule subsystems come through as planned.

• A major puzzle to U.S. space officials is the recent negative attitude taken by top Russian space officials to the prospect of putting man in space. Anatoly A. Blagonravov (See page 36) insisted that a story in *Ogonek* describing a Soviet man-in-space program was a "journalist's fairy tale," while Leonid I. Sedov said there was no point in putting a man into space until he could perform a duty which a machine could not master.

• NASA officials were frankly incredulous of the position taken by the Russians, darkly hinting that the Russians are plotting to smite the U.S. with still another incredible space accomplishment in the near future. But other officials noted that the Russians have been scrupulously honest in their space reports to date and suggested that the Russians may be desirous of writing off the importance of an astronautic program because they do not have one of their own.

• The fact that Russian aviation development appeared weak in pilot-escape systems as early as two years ago may indicate a lag in the necessary human-factors work for an early man-in-space program.

• Speaking before the Institute of World Affairs last month, NASA Administrator T. Keith Glennan reflected discussions conducted between U.S. and Soviet scientists on international cooperation in space projects during the ARS 14th Annual Meeting. Said Glennan: "As an evidence of our interest in international cooperation, we would be most happy to offer the services of our tracking network in support of the scientists of the Soviet Union when and if that nation undertakes a manned spaceflight program. Data could be acquired and transmitted in its raw state to the Academy of Sciences. . .Should special recording or data-readout equipment be required, I am sure that we would be happy to provide them or to utilize equipment furnished by the Soviet scientists." The Soviet delegation at the Annual Meeting indicated that Russia would be interested in such an arrangement.

• NASA Associate Administrator Richard E. Horner says it will not surprise him if it takes 10 yr or more before the U.S. manages to achieve a manned lunar landing.

• The Air Force has had astronauts in training for more than half a year. Also, freeflight tests of Dynasoar models have been made by Boeing at Holloman.

EXTRATERRESTRIAL LIFE?

• Two daring balloonists have come up with a long-pending answer to the question: Is there water on Venus? According to findings by Charles B. Moore of Arthur D. Little and Comdr. Malcolm Ross, USN, the planet's atmosphere definitely contains water vapor. The explorers made their finding during one hour of observing Venus at an altitude of 81,000 ft. This is high enough to avoid most of the water vapor in the earth's atmosphere, and thus to make relatively unambiguous spectrographic measurements on the perpetually shrouded planet.

• Fred Whipple, Harold Urey, and others have speculated that a vast ocean capable of supporting life covers Venus. The big question now becomes, How hot is the surface of the planet? Radio measurements suggest around 200–300 C, but they are indeterminate. Such high temperatures could well limit life in a sea to some jellyfish form. Russian space probes may answer the temperature question soon.

• On the first of this month begins another great search for extraterrestrial life. On Jan. 1, the National Radio Astronomy Observatory, Green Bank, Va., will commence a systematic study of radio emissions from the nearer stars to determine whether intelligent life is trying to communicate with our solar system. The Observatory's 85-ft radio telescope can pick up a 1000-kw signal from a distance of 15 light years. Called "Ozma" (after the Oz stories of L. Frank Baum) by its manager, Frank Drake, the project will search for "logical" transmissions on the 21-cm hydrogen band from the nearer stars—transmissions of prime numbers, the value of pi, and other constants deemed to be universal mathematical constants.

• According to Hubertus Strughold of the AF School of Aviation Medicine, there are 59 stars within 17 light years of the earth. Ruling out binary and triple stars, as well as dwarfs, there are 16 stars within this volume of space which have dimensions similar to our sun. These stars may embrace planets within their "ecospheres," or life-support zones, and there is the possibility that some of these planets will have oxygen, water, and the other ingredients necessary to sustain complex life forms.

• The moon may tell how good a possibility. As pointed out by NASA's Lunar Science Group, headed by Robert Jastrow and including Harold Urey, Thomas Gold, and Harrison Brown, the moon, not the planets, holds much of the answer to the question of extraterrestrial life: For its virtually unaged surface should bear the marks of the creation of our solar system. Should lunar geology support the theory that the solar system arose from condensed intergalactic matter rather than a "collision" of stars—and the Lunar Sci-

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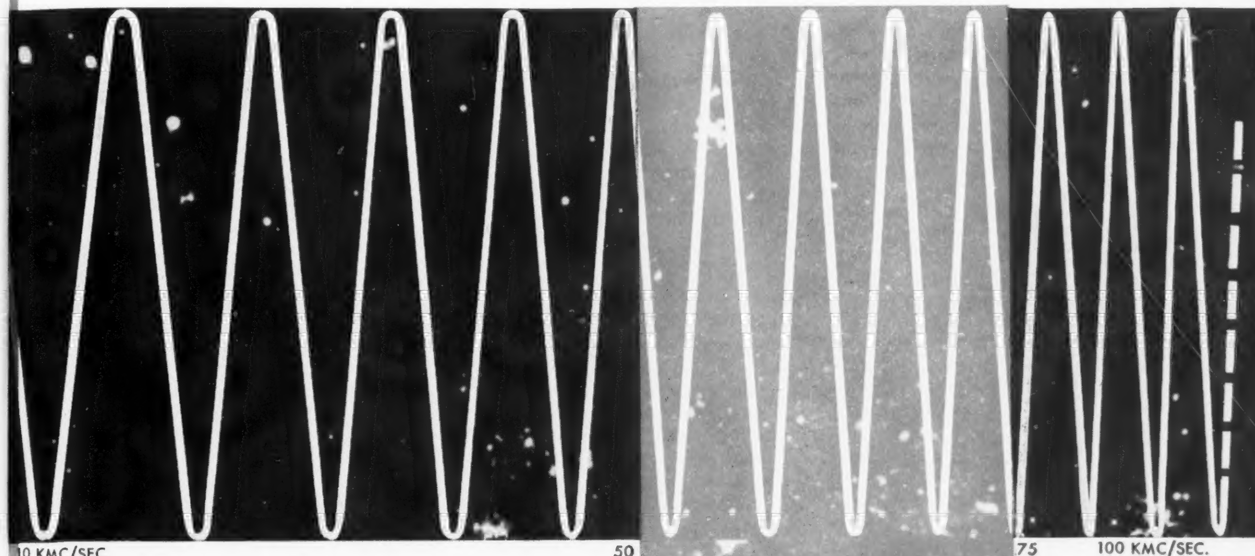

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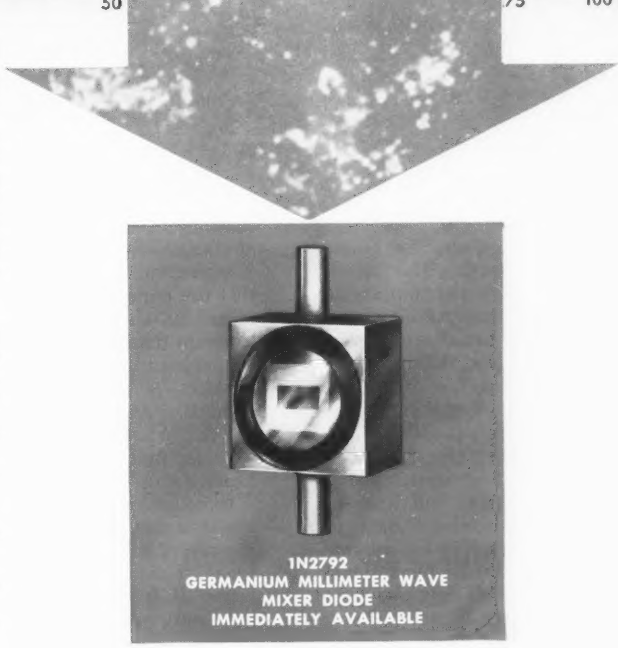
RF Impedance, VSWR	1.35	2.0	times
Crystal noise figure, NF	11.5	13	db



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ence Group strongly favors the condensation theory—planets similar to the earth will have a high probability of existing in solar systems like our own. Thus the race for the moon offers the victor a key to a riddle of the universe and the life of Man.

COMING EVENTS

• First Tiros meteorological satellite is scheduled for launching in January aboard a Thor-Able vehicle. The 270-lb satellite will carry two television cameras, scanners, tape systems, and provisions for interrogation and readout of pictorial data on the earth's cloud cover.

• The first of the 100-ft spheres planned for Project Echo is scheduled for a March launching into a 1000-mile orbit aboard a Thor-Delta rocket (See page 44).

• The initial Courier shot is planned for March. It involves a 500-lb nonoriented satellite capable of delayed-repeater operations with 20 channels at the rate of 100 words per minute. The launching vehicle will be an advanced version of Thor-Able called the Thor Epsilon. About the end of 1960, the Pentagon will seek to orbit the first of the Task Steer communications satellites into a polar orbit for realtime relay of messages in the auroral regions. An oriented vehicle with a single solar cell for power, the Steer satellite will reportedly utilize the Atlas-Agena as its launching vehicle.

• The second attempt to orbit a Transit navigation satellite is expected about April. The 265-lb payload will carry two ultrastable oscillators each broadcasting on two frequencies for broadband coverage. The Doppler shift of these frequencies will permit precise radio tracking of the position of the satellites and consequently of the tracker's position. (In the operational system, it is contemplated that ground systems will transmit precise, updated orbital data to Transit once each day for retransmission to trackers.) Operational Transit's will weigh only about 50 lb and will carry digital memory units to store navigational information. They will be powered by solar batteries and should have an orbital life of 5 yr.

• NASA is planning a series of large (almost 2 ton) astronomical observatories to be placed in 500-mile orbits beginning about 1963. Utilizing telescopes with 36-in. reflectors, the instruments would initially gather spectrographic data in the ultraviolet and infrared spectral bands. Ultimately, the instruments might also seek to resolve optical images of distant stellar and galactic objects.

• Four scientific payloads remain in NASA's Juno II program. They include an extensive cosmic radiation package built by James Van Allen, an experiment to measure the energetic gamma component of cosmic radiation, a payload for direct measurements of the ionosphere, and an ionospheric beacon satellite for relay of radio transmissions. Each weighs about 90 lb. All are scheduled for launching this year, the Van Allen package for March.

BUDGET

• An $800 million budget for NASA will be the Administration's proposed backing for the U.S. entry in the space race in fiscal 1961. Discounting the switch in Saturn funding, this would amount to a 25 per cent increase over NASA's 1960 budget. Will this provide the means to meet the Russian challenge in astronautics (See page 27)? Debate on the subject can be expected from the Congress and its space committees, which for several months have had their staffs in the field collecting information on the U.S. space program.

SPACE RESEARCH

• Top U.S. space scientists and engineers were greatly impressed by the three Russian papers presented at the ARS Annual Meeting in Washington, many commenting that the papers contained more information about the Soviet space program than had ever been made available in papers presented by Russian scientists outside the U.S.S.R. As one NASA scientist put it, "What more could you ask for than fundamental Sputnik and Lunik data? They actually gave us a complete rundown on the scientific data they've accumulated; both theoretical and analytical data on lunar trajectories; and important technical details about various experiments which have been performed. None of the papers they have presented heretofore have been as long or as precise as these."

• These papers, which will appear in the *ARS Journal*, and informal talks between American and Russian scientists indicate that simplicity and reliability are the keynotes in the Soviet space program.

• In none of their conversations with American scientists did the Russians say that work was going forward in the U.S.S.R. on even more powerful rocket engines than those they already possess. In fact, on several occasions direct questions as to whether such work was going on brought a direct "no" reply.

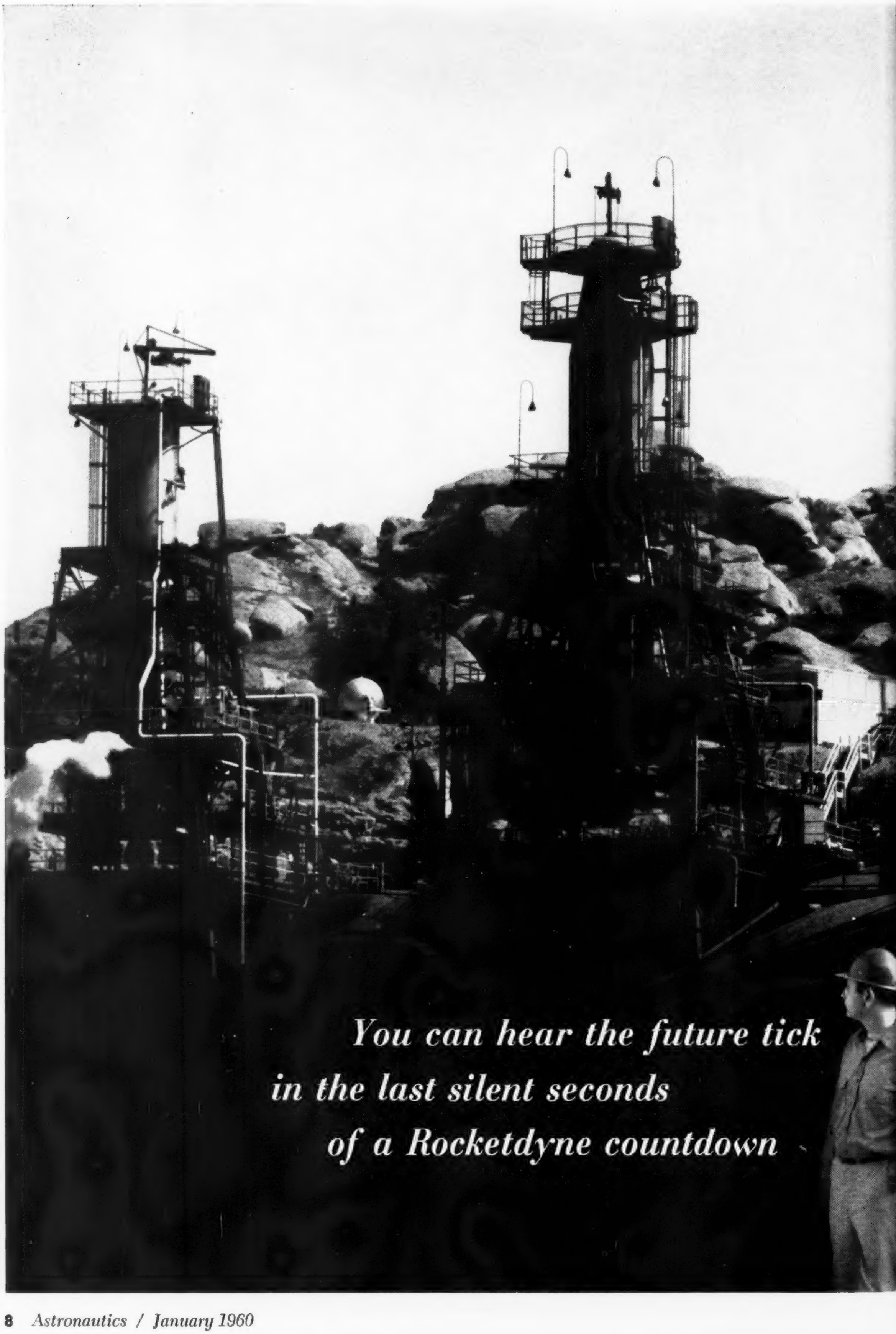
• Lunik II, which crashed into the moon on Sept. 14, 1959, detected a lunar magnetic field of 50–100 gamma, according to V. I. Krassovsky, one of the Soviet scientists who attended the 14th Annual ARS Meeting in Washington. Dr. Krassovsky noted that this field is not more than 5 per cent of the earth's. He added that Lunik II's magnetometer was sensitive to a field as small as 10 gamma.

• Dr. Krassovsky also reported that Lunik II failed to detect the presence of radioactivity on the surface of the moon. Although its instruments were sensitive to radiation one ten-thousandth as intense as the natural terrestrial background radiation, they failed to detect any increase in corpuscular radiation over that at the distance of "some lunar radii," Krassovsky said.

• Herbert Friedman's X-ray and Lyman-alpha experiments aboard Vanguard III and Explorer VII have been stymied by the unexpected presence of soft electrons at extremely low altitudes. The NRL scientist said his X-ray detector aboard Vanguard III is registering 150 kev electrons directly through its beryllium window as low as its perigee of 320 miles, except in the vicinity of Woomera, Australia, where an anomaly in the geomagnetic field thins out radiation. According to Dr. Friedman, the U.S. missed the boat when it failed to look for the soft particles (powerful fluxes of 10 kev particles at 1900 km) reported by the Russians after Sputnik III. The investment of 2 lb in a permanent horseshoe magnet around the detector window, he said, would wipe out the interference and thus permit clearcut measurements of solar radiation in future satellites.

• Findings of Explorer VI and Vanguard III tend to confirm S. Fred Singer's conception of the earth's surrounding radiation as a halo rather than highly structured radiation belts. It is becoming increasingly clear that the "radiation belt" has been seen primarily as a function of the instruments

(CONTINUED ON PAGE 10)


You can hear the future tick
in the last silent seconds
of a Rocketdyne countdown

used to measure it and that the high-energy-particle detectors used on U.S. vehicles to date have not told the whole story.

• First flight test of NASA's solid-propellant Scout booster system is scheduled for March, about 60 days behind schedule. Difficulties in scaling up Allegany Ballistics Laboratory's X-248 for Scout's third stage and the impact of vacations and holidays at Langley Research Center are responsible for the delay. NASA still expects to have the four-stage "poor man's rocket" operational by late spring or early summer.

• Discoverer VII's failure to stabilize itself in orbit has been attributed to a malfunction of a 400-cycle inverter. This is the second such traceable failure in a major vehicle. The first came when the Army failed on its first try at orbiting Explorer VII. The trouble has been remedied by potting the electrical unit in a plastic compound.

• Discoverer VIII, though a failure, at least demonstrated the success of General Electric's battery fix. Telemetry was definitely received from the beacon of the re-entry capsule after its retrorocket rammed it back into the atmosphere on the satellite's 17th pass. The orbit itself was so lopsided, however, that the satellite possibly ran short of compressed gas in stabilizing itself. In addition, its reentry angle approached the vertical, with the result that g-forces may have destroyed the instruments and prevented the deployment of the parachute. The unusual orbit (apogee of 1130 miles) was caused by an excess burning time of 3 sec in the Thor first stage.

• The Air Force has unveiled a 1700-lb, three-stage air-launched rocket designated Jaguar to be used for upper-atmosphere measurements of auroral radiation and other effects of ionized particles. Some 29 ft long, Jaguar will be capable of driving a 35-lb payload to altitudes of 500–600 miles. Launching platform will be the USAF B-57 twin-jet bomber. The rocket will consist of a first stage of three Thiokol Recruit motors, a second stage of one Recruit or its successor, the Yardbird, and a third stage of a one-fifth-scale Sergeant.

SPACE ORGANIZATION

• The National Security Council is drafting a top-level paper defining the nation's objectives in space. It's still not clear whether NSC will call for the U.S. to be paramount in space activities. Note: Preparation of the document should be a job for the National Space Council, but President Eisenhower doesn't like the Space Council and may ask Congress to kill it in 1960.

• T. Keith Glennan has disclosed that JPL will take over all of NASA's lunar and interplanetary payloads, while the Goddard Space Flight Center will take over Project Mercury and all scientific earth satellites. The laboratory at Huntsville, Ala., will have charge of the Saturn and Nova superbooster programs.

• Maj. Gen. Don R. Ostrander was appointed to the newly created post of Director of Launch Vehicles by the NASA. The 45-year-old general will take on the job about Jan. 1 on assignment from the Air Force. He will supervise all NASA booster programs, including the Scout and Centaur, as well as the Saturn and Nova superboosters. His appointment to the new position was viewed as a move to coordinate NASA booster programs at a high level within the agency and at the same time work more closely with the Air Force, which is providing most of the rocket boosters now used by NASA.

• Brig. Gen. Austin W. Betts, USA, was named to succeed Roy Johnson as Director of ARPA. (C. L. Critchfield withdrew from a tentative appointment.) Formerly Deputy Director for Guided Missiles in the office of William Holaday, Betts will now report directly to Herbert York, DOD director of Defense Research and Engineering. His appointment comes at a time when ARPA is getting out of the space hardware business. ARPA's budget next fiscal year is expected to drop to about $150 million after it turns back the remainder of its satellite programs (Courier, Steer, and Transit) to the military services.

• The Atomic Energy Commission has established a 12-man board to pass on projects which might involve the introduction of additional radiation in the earth's atmosphere or upon extraterrestrial bodies where such radiation should be excluded for scientific purposes. The group will set nuclear-safety standards for U.S. space operations and will recommend policies and procedures for space operations involving nuclear energy.

• Most of the witnesses heard by the House Science and Astronautics Committee on the question of NASA's patent practices agreed that the agency should be allowed the patent privileges of DOD. DOD contracts permit contractors to retain title to any patents they take out on inventions pursuant to any government contract, subject to a nonexclusive, royalty-free license to the government to use the invention. The Space Act, however, states that inventions made under NASA contracts are the exclusive property of the government and that the contractor can obtain right to them only by means of a cumbersome and uncertain waiver procedure.

• The U.S. and U.S.S.R. joined with seven other nations in approving a new charter for COSPAR, the international Committee on Space Research. Under the charter, membership in COSPAR will be open to all national academies of science taking part in space research by launching rockets and earth satellites.

• Nearer home, Soviet-Western differences over the proposed makeup of a permanent U.N. Committee on the Peaceful Uses of Outer Space were ameliorated, the U.S. and Russia agreeing to a 24-seat body with seven Soviet Bloc nations, five neutrals, and 12 Western members.

• NASA dropped the Vega program in view of the rapid progress on Centaur.

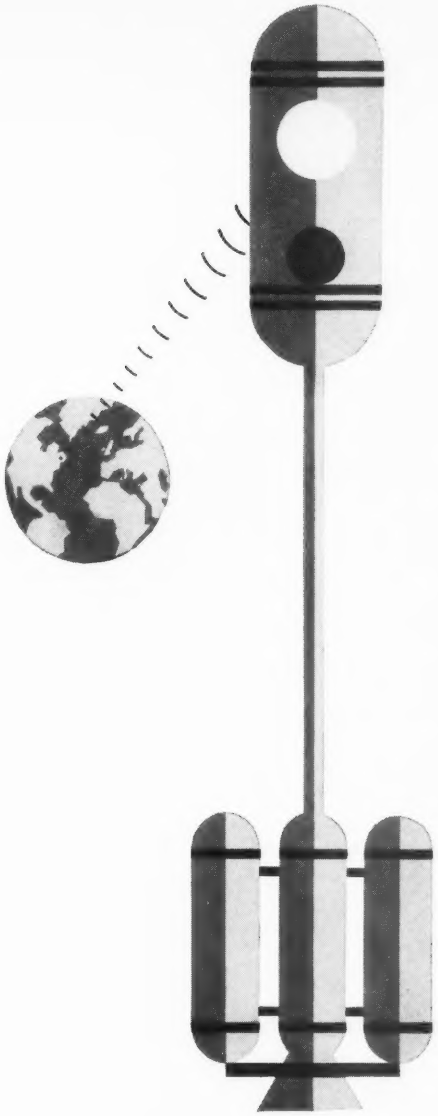
COMMUNICATIONS

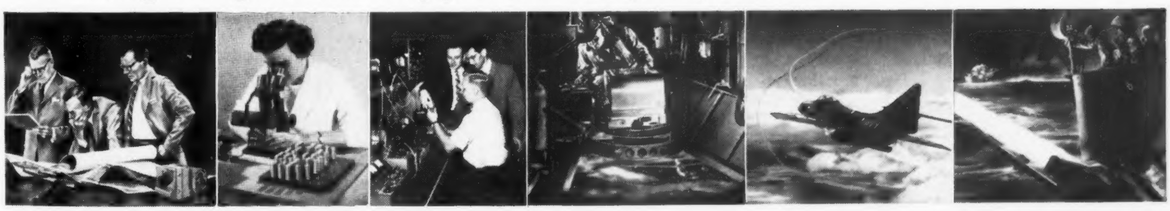
• The ITU, at its recent conference in Geneva, allocated bands 15, 150 to 15,250, and 31,500 to 31,800 mc principally to space-space and space-earth communications, and allocated 19,990 to 20,010 mc to space research on a worldwide basis.

• The unique all-solid-state 440-mc beacon transponder that last fall allowed Lincoln Labs Millstone Hill radar to track a Thor-Able at a range of 1300 miles and predict the vehicle's trajectory without down-range tracking is but the first in a series of UHF solid-state transponder systems Texas Instruments will develop for deep-space communication links.

MISSILES

• The Air Force is pondering a small solid-propellant ICBM which might be deployed by the thousands at bargain-basement prices. Only a fourth the size of the 70,000-lb Minuteman, the little





ICBM would have a low-yield (less than a megaton) warhead and only sketchy guidance. But it could be deployed in such vast numbers for a retaliation bombardment that high precision would be unnecessary.

• The military airmen are also studying the other end of the weapons spectrum: ICBM's with super warheads capable of frying hundreds of thousands of square miles. In Study Requirement 199, the Ballistic Missile Div. has focused interest upon ballistic weapons with a warhead yield ranging up to 1000 megatons—literally the "Bevaton" class. Even if the nuclear test ban remains in effect, BMD reasons that such a high-yield weapon could be devised on the basis of the present state of the art without further testing.

• As usual, offense continues to race ahead of defense. The Administration is expected to reject Army demands to place Nike-Zeus in production, but the weapon will continue as a research item for at least another year. Meanwhile, ARPA will hitch a free ride on the Zeus testing program for Project Defender. It will build a $75–$100 million installation on Roi Namur Island, 45 miles from Kwajalein Atoll, to track Jupiter IRBM missiles fired from Johnson Island 1420 miles away. The Army will try to knock down the Jupiter's with Zeus weapons positioned on Kwajalein, while ARPA merely watches the warheads with two high-power radars—a Raytheon model and a modified version of the RCA radar designed for BMEWS. A major objective of the ARPA program is to determine how early in its trajectory a ballistic warhead can be identified.

• With its decision to "re-orient" the B-70 bomber program to the status of a flight-test vehicle, the AF killed the last of its manned weapon system development programs. Forced by budgetary pressures, the move will reduce outlays for the Mach 3 aircraft from $160 million this year to $75 million in fiscal 1961. Hardest hit by the move are IBM (bombing-navigation subsystem), Westinghouse Electric (defensive subsystem) and Motorola (traffic control). North American will also recall B-70 airframe subcontracts placed with Boeing, Lockheed, and Chance Vought. Powered by six GE J93's, the B-70 should fly in 1963.

• North American is applying for its incentive bonus on the Hound Dog air-to-surface missile as a result of its second fully guided flight in late November. Based on progress to date, the supersonic weapon appears certain to meet its operational date with the B-52 in 1960. Barring crash programs, this would seem to amount to something of a record for recent Air Force hardware development programs.

• Titan recently failed on the stand for the third straight time. Its methods of assembly and preflight testing are seeing further study.

• Before bowing out as Secretary of Defense, Neil H. McElroy predicted that the first Polaris missile would be operational in the fleet by the end of 1960, as scheduled. A test Polaris recently flew a programmed distance of over 900 miles from Cape Canaveral.

R&D

• Krafft Ehricke of Convair-Astronautics says Centaur flight-testing will begin at least by 1962, followed a year later by project operations.

• Pratt and Whitney has developed the Centaur engine around a turbine pump that operates off gaseous hydrogen tapped from the fuel tank. The company has been testing versions of the pump at its Florida development center for more than two years. The motor itself (XLR-115) has been static-fired as long as several minutes.

• Scale models of Centaur's propellant tanks will be flown partially filled with cryogenic liquids to determine their behavior in weightless state. The tests will be made for NASA at WADC.

• Aerojet has also developed a hydrogen pump, but one that could drive a 500,000-lb-thrust hydrogen engine, such as might be used for an upper stage of Saturn.

• The Snap II reactor for space projects (See page 82) will be followed by Snap VIII, which with generator will be able to deliver 30 or 60 kw, depending on the size in which it is made.

• On the fusion research front, F. R. Scott of General Atomic has devised a means to inject a high-velocity jet of gas (such as deuterium) into magnetic bottles.

• Stable, standing normal, and oblique detonations produced in the laboratory for the first time were reported by Robert A. Gross in a paper given at the 52nd Annual Meeting of AIChE. According to Dr. Gross hypersonic. air-breathing propulsion systems with this form of energy release are under active study.

• ARPA contracts on solid propellants research will undoubtedly lead to refinements and depth in solid rocketry, but studies could well point to storable liquids and hybrids as the means to gain the chief goal of the program—practical high-energy propellant systems.

TEST FACILITIES

• Static-firing facilities able to handle clustered engines of the Nova class are under study for NASA and the Air Force.

• An object for speculation is the giant static-testing stand recently completed at the Naval Ordnance Test Station, China Lake, Calif. Ostensibly for testing Polaris motors, the stand is designed to take average thrust of 1 million lb and transients of 10 million lb; to accept a motor 6 ft in diam and 30 ft long; and to measure performance within 0.25 per cent. This kind of stand could test storable-liquid as well as solid-propellant rocket motors.

• A launching complex for Vega space vehicles will be built at Cape Canaveral by Convair-Astronautics under an Air Force contract that will run to more than $10 million. The Vega static-testing stand being built for Convair at Sycamore Canyon in San Diego, Calif., is nearly complete.

• Evaluation studies on a proposed multi-user space-vehicle launching complex for the Navy's base at Point Arguello, Calif., have been started jointly by Food Machinery and Chemical and Holmes & Naver, Engineers and Constructors. The complex would handle both ballistic-missile and space-vehicle launchings.

MATERIALS

• The assault on the thermal barrier is showing a variety of promising approaches. Some recent announcements:

• Thin ablating skins of TFE-fluorocarbon resins may be one solution to lightweight re-entry shields, according to Du Pont engineers, who have tested their "Teflons" in plasma jets to correlate performance with calculations of heat transfer and erosion. . . NASA will test

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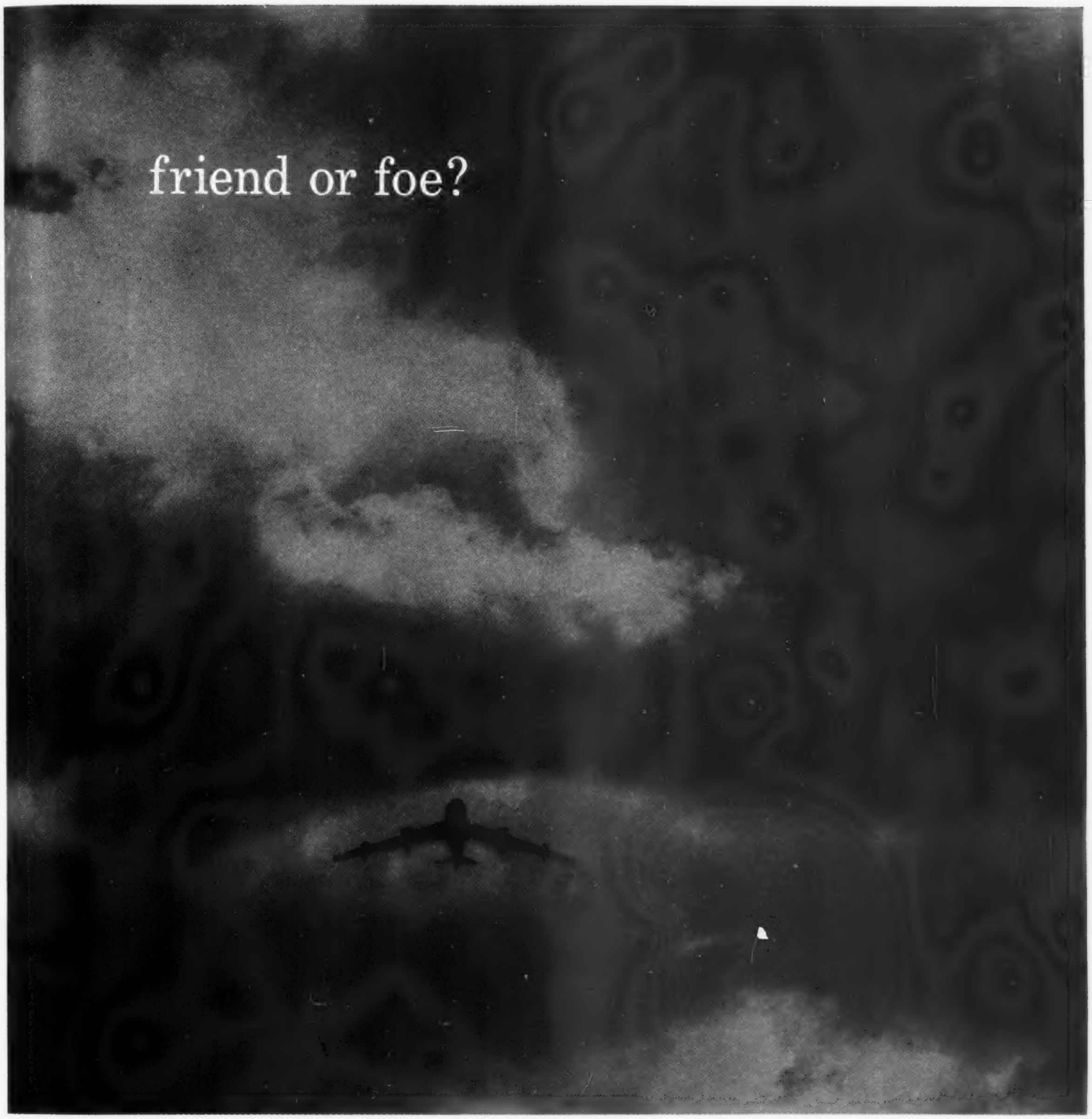

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For the record

The month's news in review

Nov. 3—Army Signal Corps at Fort Monmouth, N.J., discloses that two shells of energy—trapped electrons and hydromagnetic waves—not one, were created around earth during Project Argus experiments last year.

—AF launches Thor some 1700 miles.

Nov. 4—NASA successfully field-fires and recovers Mercury emergency escape system.

—Charles L. Critchfield, Convair director of scientific research, is named to succeed ARPA director Roy W. Johnson.

—Army fires Jupiter 1500 miles; AF successfully test-fires Atlas 6000 miles.

Nov. 7—AF launches Discoverer VII into polar orbit, but instrument capsule fails to separate due to electrical malfunction.

Nov. 9—AF awards Dynasoar development contract to Boeing and Martin.

Nov. 10—Univ. of Michigan scientists launch a 5-stage rocket from Wallops Is. 1050 miles high to measure ionospheric electron density.

Nov. 14—Charles L. Critchfield withdraws from his appointment as ARPA chief.

—Soviet Union says it has lost radio contact with Lunik III.

Nov. 16—AF Capt. Joseph W. Kittinger makes record parachute jump from more than 14-miles altitude in test of space equipment, first falling freely for some 12,000 ft.

—ITT announces development of ferroelectric converter having wide implications in space communications and travel.

—Scientists at Space Labs, Inc., Van Nuys, Calif., reveal having embedded a 2-oz radio transmitter in a dog's body without ill effects on the animal.

Nov. 18—AEC announces development of 220-lb nuclear reactor, Snap II, for advanced space vehicles.

—NASA officially takes over Saturn program from DOD.

—NASA successfully launches 5-stage rocket, trailing sodium vapor.

Nov. 19—NASA Chief T. Keith Glennan says his agency will ask for "substantially more" than $500-million budget of last year.

Nov. 20—AF sends Discoverer VIII into orbit, but fails to retrieve its 27-in. nose cone.

—Navy successfully test-fires Polaris missiles from land and sea.

Nov. 21—Cornell Univ. announces it will set up a Center for Radiophysics and Space Research, including 1000-ft radar at a Puerto Rican site.

Nov. 23—DOD permits AF to increase Mace production by about $100 million.

—Soviet magazine *Znamya* names Mikhail K. Tikhonravov and Igor A. Merkulov as top men in Russia's recent space triumphs.

Nov. 24—AF test-fires Atlas.

—GE shows "first radio-optical observatory."

—U.S. and U.S.S.R. sign pact for joint atom research.

Nov. 26—U. S. moon shot fails, owing to premature breakup of nose cone's plastic sheath.

Nov. 27—NASA postpones further moon shots until well into 1960.

Nov. 29—Navy balloon with 2-man crew rises 15 miles in study of Venus; data indicate water vapor in the atmosphere of Venus. ♦♦

International scene

BY ANDREW G. HALEY

The good news has been officially issued by the Argentine Interplanetary Association (Asociacion Argentina Interplanetari, Viamonte 867, Buenos Aires, Argentina) that it will act as host for the Second InterAmerican Symposium on Astronautics. The invitation has been issued by Teofilo M. Tabanera, honorary president of the AAI and one of the pioneers in international astronautical cooperation. The announcement was also signed by Aldo Armando Cocca, an attorney and Minister of Culture of the Province of Buenos Aires.

The AAI suggests that the Symposium be held in Buenos Aires sometime between January and March in 1960. The meeting will also be sponsored by the Brazilian Interplanetary Society (Sociedade Interplanetaria Brasileira [SIB], Caixa Postal 6450, Sao Paulo, Brazil).

In addition to the direct sponsorship of the Argentinian and Brazilian societies, the Symposium will have the support of the Argentina Ministry of Aeronautics and of the Santos Dumont aerospace research organization of the government of Brazil.

The First InterAmerican Symposium on Astronautics was held in Sao Paulo, Brazil, July 14–15, 1959, under the auspices of the SIB. The writer represented the International Astronautical Federation and delivered a paper. The AMERICAN ROCKET SOCIETY was represented by Joseph P. Haley, an engineer from Seattle, Wash. A brief résumé of that meeting will serve to indicate what may be expected at the forthcoming Buenos Aires Symposium.

The Sao Paulo meeting was remarkably successful in every respect. It produced excellent papers and a good attendance. Living in Latin America are many first-class physicists and engineers who specialize in various aspects of astronautics, and are very desirous to hear from their colleagues in other parts of the world, such as from L. I. Sedov, Theodore von Kármán, William H. Pickering, Eugen Saenger, L. R. Shepherd, Paul J. Bergeron, R. Pesek, and G. Arturo Crocco. It is the earnest hope of this writer that funds from Foundations will be made available to bring to Buenos Aires, without cost to the lecturers or to the local societies, such experts who by their very presence will contribute to international understanding and cooperation.

The meeting was officially convened on the evening of July 14, 1959 at the Univ. of Sao Paulo by Thomas Pedro Bun, president of SIB, who read the inaugural address of Teofilo M. Tabanera. The writer presented the greetings of the IAF and delivered his inaugural address. Joseph P. Haley presented the greetings of the ARS. Surprising interest was shown in the subject of astronautics, because the question and answer period lasted for almost two hours. Our great friend, Honorary President Luiz de Gonzaga Bevilacqua, came all the way from Baurú to participate in the opening of the lecture series. We were particularly honored by the presence of Air Marshall Luiz Netto Dos Reys, director of the Institute of Santos Dumont, a state-supported aeronautical organization, and also by Col. Aldo Vieira da Rosa, head of the aeronautical dept. of the Technical Univ.

The next morning, July 15, we convened at 8 o'clock at the University to attend the technical sessions. We were honored by the presence of Air Marshal Dos Reys and Col. da Rosa, and many other distinguished persons and members of the Societies. Old friends of Dr. von Kármán seemed to be most plentiful, including the Air Marshal, Prof. Philip Smith, Dr. Bevilacqua, and Col. da Rosa. Because we had to leave in the afternoon to arrive in Buenos Aires that night, the writer was permitted to speak first. Thereupon ensued a most interesting and excellent technical program which lasted the rest of the day. Lectures were delivered by the distinguished Flavio Augusto Pereira, vice-president of the SIB, Ove Schirm, and Thomas Pedro Bun.

The Second InterAmerican Symposium will undoubtedly follow the pattern of the first, and in Argentina we may expect the patronage of not only many famous scientists but also of such official personages as Air Marshal Angel Alberto Garcia Bollini, director of Civil Aviation, and his staff, including many well-known physicists, engineers, and lawyers. Memorable meetings will be arranged at such places as the American Club, under the auspices of José O. Martinez, the very capable and famous petroleum engineer who is vice-president of the AAI. The meeting will also be supported by Rogelio Iribarren, Julio E. Rossi Bossisio, Marcelo Barrera Gutierrez, Ricardo Dyrgalla, Capt. Ricardo Bogliano, and many other distinguished officials.

The ladies who attend the meeting may expect the pleasant company of one of the most famous of honorary astronauts, Herminia Tabanera, who has been a representative of the Argentina Society at all but two of the IAF Congresses.

° ° °

The First International Space Science Symposium, to be held under COSPAR auspices in Nice, France, Jan. 11–16, will be devoted to scientific problems that fall within the COSPAR Charter. Papers presented at the meeting are expected to deal with tracking, telemetry, radiation belts, orbital variations, meteors, magnetic fields, ultraviolet radiation and other subjects relating to space science, but not with propulsion and allied subjects. It is hoped that a day will be devoted to the biosciences, including methods of testing for extraterrestrial life and sterilization of space vehicles.

° ° °

The Danish Astronautical Society (Dansk Astronautisk Forening) marked its 10th anniversary in September. Founded Sept. 20, 1949, and the first astronautical society to be formed after WW II, the Society was organized by E. Buch Andersen, who served as president from 1949 to 1955, and Leo Hansen, who served as vice-president from 1949 to 1955 and as president from 1955 to the present time. The Society was host to the 6th International Astronautical Congress in 1955.

Since there is no rocket society or scientific activity relating to astronautics in Denmark, spaceflight is, at least at present, only a hobby for Society members. Its major aim is to make the science of astronautics better known and understood in the country.

The Society's Newsletter No. 9, published in September and marking the anniversary, includes a standardized vocabulary of astronautical terms in Danish and English which has been presented to the Danish Central Institute for Technical Terminology for consideration.

° ° °

Next month's column will discuss the Chinese—the National Republic of China and the Peoples Republic of China, and their separate astronautics efforts. ♦♦

NUMBER NINE IN A SERIES... PERFORMANCE
PRECISION
FLOW
TEMPERATURE
ENDURANCE
SHOCK
ALTITUDE
HUMIDITY
PRESSURE

COVER: *"The Thinker," a painting by Ed Ryan, suggests the present plight of a troubled world as it enters the Space Age.* (ASTRO full-color cover plaques, 11 × 12 in., are available from ARS Headquarters for $2.00 each.)

Astronautics

JANUARY 1960

The 1959 Annual Meeting

The 14th Annual ARS Meeting in Washington sparkled with excitement and action, and I deem it a privilege, as my first communication with the 20,000 readers of *Astronautics,* to comment on some of the events of the meeting.

First, the triple and sometimes quadruple sessions provided a stimulus for every technical temperament, from the designer of rocket transporters to the educational philosopher. For those with schedule conflicts, a mountainous stack of preprints provided the essential content of the papers. (About 90 per cent of the papers were available as preprints, including the full texts of the Russian papers.) The efforts of many of our technical committees bore fruit for the first time at this meeting. For example, there were separate sessions on ion propulsion and plasma propulsion, as well as two excellent classified sessions on nuclear propulsion, among many others no less interesting. It was evident from listening to these presentations that the percentage of top quality papers is rising, and it is of course our aim as a society to continue this trend.

The informal and nontechnical aspects of the meeting were fully as interesting as the technical. The many dedicated ARS officers and committee members met in a series of 20 sessions, often depriving themselves of the opportunity to hear papers, and, with much vigorous debate and independence of thought, hammered out programs and policies for the year ahead. It is apparent from their thinking that 1960 will have a greater variety of specialist conferences than any previous year.

The Section Delegates Conference, presided over by Wernher von Braun, was attended by a roomful of Section Presidents, many of whom described activities in behalf of the youth program, and was characterized by vigorous discussion. The luncheon and banquet addresses included talks by Pickering, von Braun, Sutton, and McCone, all men so situated that their thoughts will profoundly influence the U.S. space program. There was even a photograph distributed at one luncheon showing the sodium vapor cloud resulting from an upper atmosphere firing the previous evening!

Perhaps the most newsworthy event of the meeting was the presentation of three major papers and a film by three Russians prominent in the U.S.S.R. space effort. The papers related to instrumentation of payloads, physics of space, and trajectory and other problems associated with photographing the far side of the moon. These were carefully prepared documents which gave considerable insight into the state of art of space measurements in the U.S.S.R., and, as was to be expected, revealed a soundly based technology. The presence of the Soviet delegation is an auspicious beginning to what we hope will be continued interchange of information.

In summary, the Washington meeting was a vivid demonstration of the vigor and health of your Society during 1959 and a promise of an even more active year ahead.

Howard S. Seifert
President, American Rocket Society

Leonid I. Sedov (left) and Col. John P. Stapp, representing the Soviet Academy of Sciences and ARS, respectively, exchange tokens of esteem—scale models of Lunik III and the Vanguard rocket—at the Honors Night Dinner of the 14th Annual ARS Meeting.

A historic annual meeting

Attendance of 6000 marks 14th Annual ARS Meeting in Washington, attended by Russian delegation for the first time . . . Seifert elected President, Ritchey Vice-President . . . Five new Board Members named

By Irwin Hersey

FROM ALL standpoints, the 14th Annual Meeting of the AMERICAN ROCKET SOCIETY in Washington, D.C., November 15–19, was a historic one, and one which is likely to remain for some time to come in the memories of those who were fortunate enough to attend.

There was little doubt in the minds of those ARS members who did attend that this was the biggest, and best, meeting in the Society's history, from almost every standpoint—the type of meeting which is likely to set a standard not only for future ARS meetings, but for those of other societies as well.

Seifert Heads Society

Heading the Society for 1960 are Howard S. Seifert, of Space Technology Laboratories, as President, and Harold W. Ritchey, of Thiokol Chemical Corp., as Vice-President. Robert M. Lawrence, of Thiokol, continues as Treasurer, Andrew G. Haley as General Counsel, and James J. Harford as Executive Secretary.

Five vacancies on the ARS Board were also filled at the meeting. Martin Summerfield, of Princeton Univ., Editor of *ARS Journal*, was re-elected for a three-year term. Newly elected for three-year terms were Ali B. Cambel, Northwestern Univ.; Robert A. Gross, Univ. of California Livermore Radiation Laboratory; Richard B. Canright, Douglas Aircraft Co. Missile and Space Systems Div.; and Herbert Friedman, U.S. Naval Research Laboratory.

In addition, William L. Rogers, of Aerojet-General Corp., a Board Member for the past year, was named by the Board to fill out till 1960 the unexpired term of J. Preston Layton, James Forrestal Research Center, Princeton Univ., who has resigned because of the press of business.

Col. Stapp (left), retiring ARS president, welcomes his successor, Howard S. Seifert, to office and presents him with the gavel in Honors Night ceremonies.

Attendance at the meeting soared to a record 6000, including a total registration of 4200, attendance of some 1200 at the Astronautical Exposition, a press delegation of well over 100, and several hundred people who dropped in to attend one or more of the Luncheons and the Honors Night Dinner.

Highlights of the meeting are almost too numerous to mention, but certainly the presence of the first Soviet delegation ever to attend in this country a society meeting devoted to rocketry and astronautics provided the meeting with some of its outstanding moments.

The five-man delegation, representing the Soviet Academy of Sciences at the meeting, was headed by Leonid I. Sedov, chairman of the Academy's Commission for Interplanetary Travel, and IAF President. Other members were Anatoly A. Blagonravov, member of the Presidium of the Academy; Valerian I. Krassovsky, chief of the Department for Research in Upper-Atmospheric Physics of the Academy's Institute of Atmospheric Physics; Vitaly G. Kostomarov of the Academy's Foreign Department, who did yeoman work as the delegation's interpreter; and Yuri S. Galkin, secretary to Prof. Blagonravov and delegation secretary.

Russians Present Papers

Three technical papers, providing a good deal of new and very valuable information on scientific and

NEW BOARD MEMBERS

Ali B. Cambel

Richard B. Canright

Herbert Friedman

Robert A. Gross

technical aspects of the Soviet space program, were presented by members of the delegation. Prof. Sedov presented a paper on "Orbits of Soviet Cosmic Rockets toward the Moon" (ARS Preprint 1051A-59); Prof. Blagonravov, a paper on "Some Problems of Providing for Scientific Research on Rockets" (ARS Preprint 1052A-59); and Prof. Krassovsky, a paper on "Results of Scientific Investigations Made by Soviet Sputniks and Cosmic Rockets" (ARS Preprint 1050A-59).

The Russian papers, to be printed in full in the January *ARS Journal*, were presented before an audience of well over 1000 at a special evening technical session devoted to "Latest Events in Spaceflight," chaired by Abe Silverstein of NASA. The session also included three American reports covering Vanguard III, Explorer VI, and U.S. sodium vapor experiments.

The previous evening, during a session devoted to Man in Space, Prof. Blagonravov showed a fascinating 30-min film dealing with Soviet weightlessness experiments, and then spent some 45 min answering questions about the film and Soviet experimentation in this area. (See page 36.)

The Soviet delegation brought to the meeting a gift from the Academy of Sciences for ARS—a handsome, beautifully machined model of Lunik III, which they presented to Col. John P. Stapp, 1959 ARS president, at the Honors Night Dinner. In exchange, Col. Stapp presented to the Russian delegation, for the Academy, an equally handsome model of the Vanguard vehicle, made available through the courtesy of Martin Co.

The delegation also paid a two-hour visit to the Astronautical Exposition and were favorably impressed by the exhibits. Of course, everywhere the delegation went, individual members were buttonholed by ARS members anxious to learn more about the Soviet space program. (See page 34.)

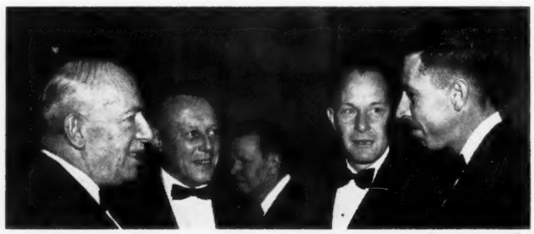
The Honors Night Dinner, always a highlight of the Annual Meeting, on this occasion drew a record attendance of more than 1500 ARS members and guests gathered to pay homage to those selected to receive the highest honors bestowed in the fields of rocketry and astronautics.

The Robert H. Goddard Memorial Award, for outstanding work in liquid rockets, went to Samuel K. Hoffman, vice-president of North American

AT THE DIRECTORS' RECEPTION

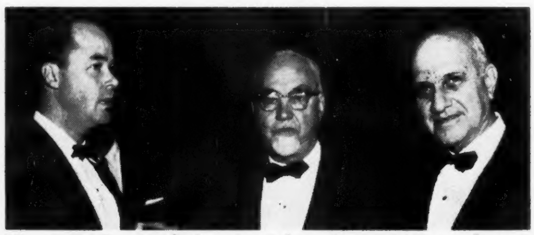
From right, A. K. Oppenheim, Martin Summerfield, Howard Seifert, and John Sloop appear to be enjoying the remarks of Maurice Zucrow at far left.

T. Keith Glennan (left) and John A. McCone pause thoughtfully in discussion.



A. J. Eggers, far right, gives a maybe-so, maybe-so reply to Harold Ritchey, Karel Bossart, and Walter Dornberger, in that order from his right.

From left, Krafft Ehricke, Milton Rosen, Antoni Oppenheim, and Irwin Hersey look pleased at the success of the meeting.



Harry F. Guggenheim, at right, gives a tip on photographers to James J. Harford (left) and G. Edward Pendray (center).

Aviation and general manager of its Rocketdyne Div., while Ernest Roberts, research manager of Aerojet-General's Solid Rocket Plant, received the C. N. Hickman Award for outstanding work in solid rockets. Ali B. Cambel received the G. Edward Pendray Award for outstanding contributions to rocket and astronautical literature; Walter Dornberger, vice-president for engineering, Bell Aircraft Corp., the ARS Astronautics Award for outstanding contributions to the advancement of spaceflight; and Karel J. Bossart, assistant to the vice-president for engineering, Convair, the James H. Wyld Memorial Award for outstanding application of rocket power.

Student Awards

The ARS-Chrysler Corp. Student Award, and a check for $1000, went to Thomas Miles Conrad of Oberlin College for his outstanding paper on "The Drift Transistor in Advanced Space Communications" (ARS Preprint 947-59), judged to be the best undergraduate paper on astronautics or a related subject—and one of the finest ever offered in the competition.

The ARS-Thiokol Student Award, and a check for $1000, went to Gordon H. Miller, a 42-year-old engineer working for his Ph.D. at the Univ. of Michigan, symbolic of the fact that, as one ARS member put it, "everyone in this business has to keep studying just to stay abreast of what's going on." His paper, judged the finest in the graduate student competition, was entitled "Feasibility Study of Atomic-Powered Rockets" (ARS Preprint 946-59).

Both of these papers were read at the Annual Student Conference, which also attracted a good turnout.

Another highlight of the Honors Night Dinner was the presentation of a surprise gift to A. C. (Billie) Slade, secretary and assistant treasurer of the Society, in commemoration of her 15th anniversary as a member of the ARS staff.

In addition, 21 ARS Fellow Memberships were awarded for outstanding contributions to rocketry and spaceflight or exceptional service to the Society, during the course of the meeting. New Fellow Members are Kurt Stehling, NASA; Raemer Schreiber, Los Alamos Scientific Laboratory; Milton Rosen, NASA; Eberhard F. M. Rees, ABMA; Walter T. Olson, NASA Lewis; Lester Lees, CalTech; Kurt H. Debus, ABMA; John I. Shafer, JPL; William Avery, Johns Hopkins; Maj. Gen. L. I. Davis, AF assistant deputy chief of staff, development; Thomas F. Morrow, Chrysler; Homer J. Stewart, NASA; James Van Allen, SUI; William G. Purdy, Martin-Denver; T. Keith Glennan, NASA; Richard D. Geckler, Aerojet; A. L. Antonio, General Tire; David A. Young, Aerojet; Kurt Berman, GE; Robert M. Lawrence, Thiokol; and James J. Harford, ARS.

Above, members of the Russian delegation—from left, Valerian I. Krassovsky, Anatoly A. Blagonravov, and Leonid I. Sedov—confer with their fine interpreter, Vitaly G. Kostomarov, before presenting papers at a special evening session of the 14th Annual Meeting. Below, at top, Prof. Blagonravov and, at bottom, Prof. Sedov delivering their papers, and Prof. Krassovsky making a point at the blackboard.

The Meeting did itself proud in the technical session department, with some 110 papers presented at 29 sessions, in addition to a number of panel discussions and off-the-cuff reports on late developments. The 29 sessions (which included five classified sessions) covered almost every facet of ARS activity, reflecting the broad scope of the Society's current interests. Despite the fact that the large number of sessions necessitated the scheduling of quadruple (and even, in one instance, quintuple) sessions, attendance was good throughout the meeting.

The Astronautical Exposition, held in the Exhibit Hall of the Sheraton-Park Hotel, scene of the meeting, and an auxiliary area on the lobby floor, covered

an area of some 14,000 sq ft and included exhibits by more than 70 of the nation's top missile and astronautical equipment and component manufacturers. Demonstrating some of the progress made in these areas during the past year, the Exposition drew a large attendance during the three days it was open. (See page 28.)

Sections Report Growth

The Annual ARS Section Delegates Conference was also well attended. All Sections reporting noted good growth during the past year. Several announced that they had established speakers bureaus for the convenience of local civic groups anxious to obtain speakers knowledgeable in the fields of rocketry and astronautics. Many Sections are also working with local science councils on the amateur rocketry problem. The Detroit Section announced that it had paid the expenses for two outstanding students in its area to attend the meeting and the Student Conference, and suggested that other Sections might adopt this idea.

ARS members in attendance at the Annual Business Meeting heard of a growth in membership of approximately 4500 during the year, bringing total membership over the 15,000 mark. The financial report indicated a surplus of $76,664 during the year, with about half this amount contributed by the two Society publications. New ARS officers for the coming year were elected at the meeting.

The Board meeting produced a unanimous vote approving the establishment of three ARS Regional vice-presidents; approval of a move to allow students to attend regional Special Subject Conferences on a seat-available basis; and unanimous adoption of a resolution calling for development

HONORS NIGHT AWARDS

Samuel K. Hoffman accepts the Robert H. Goddard Memorial Award for outstanding work in liquid-propellant rocketry from Mrs. Goddard.

Karel J. Bossart accepts the James H. Wyld Memorial Award for oustanding application of rocket power from Mrs. Wyld.

Walter R. Dornberger (left) receives the ARS Astronautics Award for outstanding contribution to the advancement of spaceflight from Andrew G. Haley.

of a positive ARS program to encourage youth education in the sciences of rocketry and astronautics.

Promoting Education

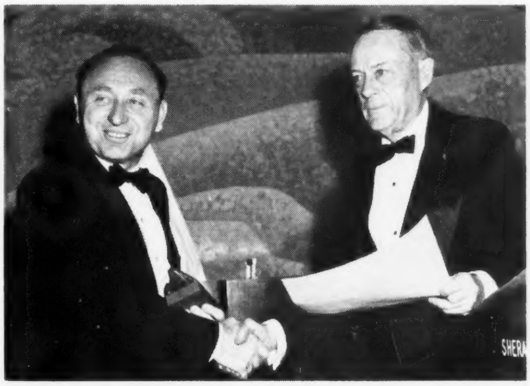
The resolution charges the Society's Education Committee with the task of recommending additional positive steps to stimulate youth education in these fields and recommends that "ARS efforts outside the Society. . .be based on the principle of encouraging interested and responsible youth organizations, such as the Boy Scouts of America, Science Clubs of America, and similar organizations, to undertake on their own serious educational programs along safe lines."

It was adopted after a review of the Society's stand on amateur rocket experimentation using explosive propellants and an opinion by legal counsel for ARS that the Society could legally neither carry out nor sponsor experimentation.

Another highlight of the meeting was the first public announcement of the Society's "Spaceflight Report to the Nation," to be held in the New York City Coliseum, Oct. 9–13, 1961. Complete details will be found on page 39.

The ARS Marketing Symposium, rapidly becoming a regular feature of national meetings, drew a record attendance of more than 250. The panel for the meeting, chaired by ARS Executive Secretary James J. Harford, included Maj. Gen. William T. Thurman, AF production programing specialist; Kurt Stehling of NASA; Buford M. Brown of Westinghouse; Harlowe J. Longfelder of Boeing's Aerospace Div.; and Art Gilbert of Bendix Systems Div.

The four luncheons held in the course of the meeting all drew large audiences anxious to hear addresses by such prominent figures in the fields of

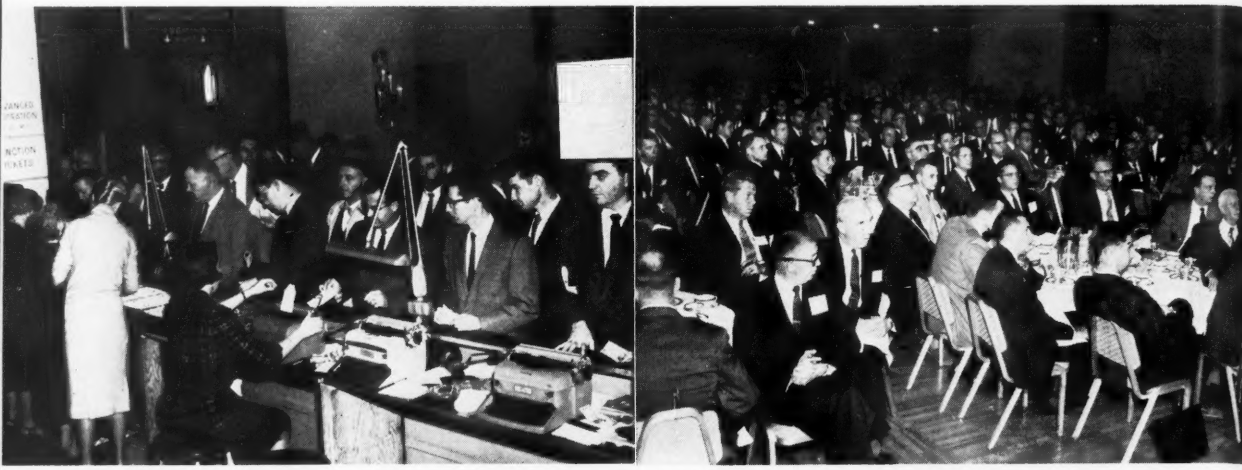


Ernest Roberts (left) receives the C. N. Hickman Award for outstanding work in solid-propellant rocketry from Dr. Hickman.

Ali Bulent Cambel (right) accepts the G. Edward Pendray Award for outstanding contributions to rocket and astronautical literature from Dr. Pendray.

Thomas M. Conrad (left) of Oberlin College receives the ARS-Chrysler Corporation Student Award from C. A. Brady of Chrysler.

Gordon H. Miller (right) of the Univ. of Michigan receives the ARS-Thiokol Corporation Graduate Student Award from J. T. Grey of Thiokol.



Members register (left) and jam the banquet hall (right) to hear this array of speakers (left to right): Wernher von Braun, Brig. Gen. Homer A. Boushey, William H. Pickering, John A. McCone, and George P. Sutton.

rocketry and astronautics as Wernher von Braun of ABMA; Brig. Gen. Homer A. Boushey, AF director of advanced technology; William H. Pickering, JPL chief (see page 27); and George Sutton, chief scientist of ARPA.

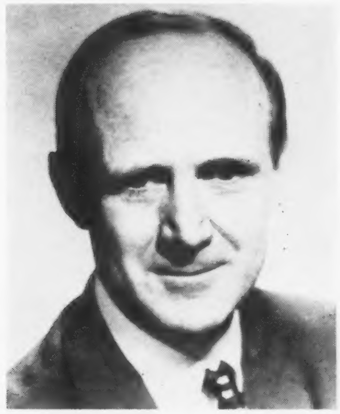
Dr. von Braun, chairman of the ARS Membership Committee, devoted his address to a discussion of "Youth—and the AMERICAN ROCKET SOCIETY," reviewing the proposed program by the ARS Youth Workshop last September and specifically recommending the adoption of two planks in the program, one dealing with the establishment of a pilot program in astronautics by the Boy Scouts with ARS assistance, and the other calling for ARS-backed Youth Space Fairs.

Above, Wernher von Braun (top left) presents N. Elliott Felt Jr. of the Maryland Section with one of the certificates of merit awarded several past Section presidents. In foreground, William H. Roennau (left), acting president of the National Capital Section, and Col. Stapp.

In his address on "The Air Force's Future in Space," Gen. Boushey considered the question of whether there was any real need for military space operations and came up with a resounding "Yes" answer, noting that military space projects, such as communications, early warning, and reconnaissance satellites, must be carried forward and maintained as matter of urgency for our national survival. Projects such as these, he added, can actually promote the cause of peace, and in many areas can do so more effectively than any other devices.

Prof. Sutton's talk, entitled "In and About Space," was devoted to a review of the last year's progress in astronautics and future prospects. In his address, he noted that $1^1/_2$ per cent of the 1961 fiscal budget is likely to be devoted to space projects—more than the federal government spends running the Commerce Dept. or on aid to (CONTINUED ON PAGE 74)

Do we have a space program?



William H. Pickering

This thoughtful address, delivered at the ARS Annual Meeting, urges the establishment of long-term goals for the U.S. program and frank recognition of the fact that we are in a space race with the Russians

By William H. Pickering

DIRECTOR, CALIFORNIA INSTITUTE OF TECHNOLOGY, JET PROPULSION LABORATORY

I WAS particularly pleased to see Brig. Gen. H. A. Boushey on the program as one of your speakers. Gen. Boushey is an old friend at my laboratory. As he mentioned yesterday, in 1941 he flew the first Jato-equipped aircraft in the U.S., a small Ercoupe equipped with jet-assisted-take-off solid rockets developed at the Jet Propulsion Laboratory.

When Gen. Boushey, then Capt. Boushey, sat in the small airplane on the runway at March Field warming up his engine for the first Jato flight, there was a certain urgency to the experiment.

A great war was at the time spreading through Europe and was ultimately to involve the U.S. The Jato experiment was to play a part in the outcome of that war.

With one important difference, there is a certain parallel between that first Jato flight 18 years ago and the preparation the U.S. is now making for the exploration of space and the placing in orbit of a Mercury astronaut.

The important difference is that the nations of the world have since learned that a war can be fought and won on fronts other than actual battlefields—that a cold war has strategies, campaigns, and victories just as important as a hot war.

A hot war has as its objective the physical taking of territory, the unremitting pounding of the enemy by bombs, artillery, and other weapons until foot soldiers can move in and take possession of his land.

A cold war is perhaps more humane, but is equally deadly in its consequence: It is fought for the control of the minds of men. The target is the domination of the emotions and intelligence of men everywhere; and instead of being conducted by tanks, aircraft, and naval vessels, it is fought in financial markets, in newspapers, on radio and television programs, and by word of mouth.

Drawn up in this conflict are two political philosophies: Both strong, both competitive, and both resourceful.

A Campaign in Space

One philosophy says simply that the mind of man functions most nobly and achieves its greatest expression when it is free. The other says that the mind of man is subordinate to the will of the state. It is the U.S. against Russia, and its most important campaign is being fought far out in the empty reaches of space.

The subject of my address today is simply: How are we doing in this campaign in space?

If we look at the history of the past two years, it is apparent that the U.S. reacted violently to the first Russian Sputnik with the assertion that we would now establish our own space program and that we would very quickly equal the achievements of the Russians. Since that time, as we all know, NASA and ARPA were (CONTINUED ON PAGE 83)

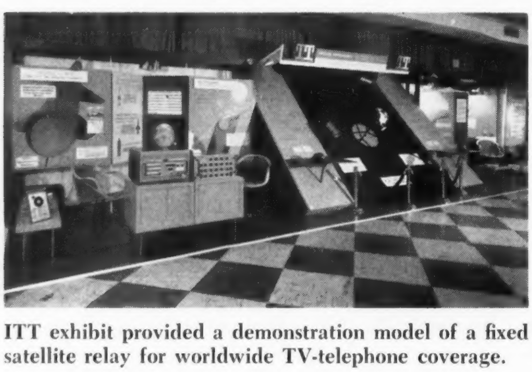
During a lull, looking down half the length of one aisle in the Exhibit Hall of the Sheraton-Park Hotel, where the extensive exhibition was staged in conjunction with the 14th Annual ARS Meeting.

At the Astronautical Exposition

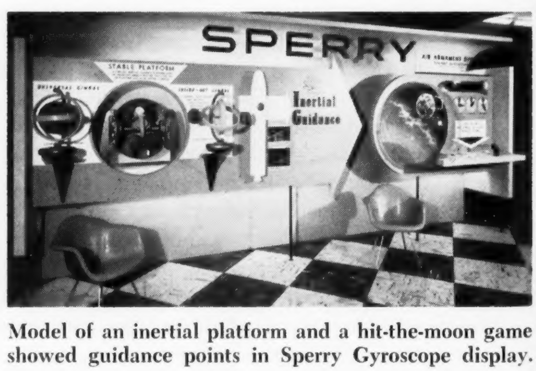
The Astronautical Exposition of the 14th Annual ARS Meeting provided a panorama of industry plans and progress in missiles and spaceflight

Boeing Airplane showed models of its countermoon and manned spacestation proposals with graphic exhibit.

Auxiliary-power and heat-exchange system based on hydrogen formed nucleus of Vickers Inc. display.

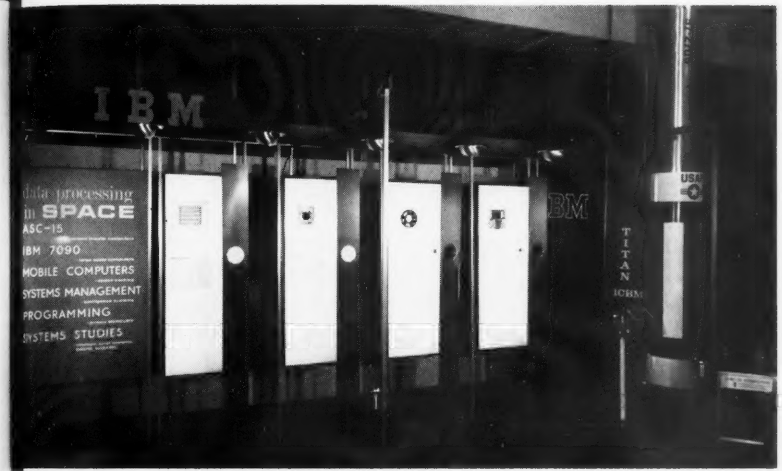


ITT exhibit provided a demonstration model of a fixed satellite relay for worldwide TV-telephone coverage.



Model of an inertial platform and a hit-the-moon game showed guidance points in Sperry Gyroscope display.

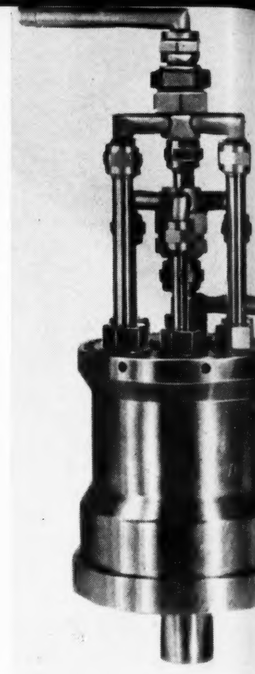
Raytheon's panorama of its wide participation in space and missile systems was augmented with movies on aisle screen.



Key components developed by IBM for missile and space-vehicle computers and associated equipment drew emphasis in data-processing display.

Early visitors to Westinghouse Air Arm Div. booth beat the crowd in talking down a re-entry vehicle through board model.

GE's Missile and Space Vehicle Dept. indicated the wide scope of its laboratory programs with research displays, including Discoverer re-entry vehicle hardware and analog simulator of interplanetary transfers in two dimensions.



External view of ORM-1, the first Soviet liquid-fuel engine.

Behind the Luniks

This account of early Soviet rocket and jet propulsion experimentation by a Stalin prize-winning Russian scientist, himself an early experimenter, reveals a history going back some three decades

Background

To some, the pioneering scientific and engineering exploits of the Russians in astronautics appear to arise out of a vacuum or a pilfered technology, and there is still a slight tendency to see the Russian space program as a borrowed one, limited in its consequences by lack of engineering depth and continuity.

The Russians do not share this view, and their recent achievements indicate how erroneous it is. The Russians see these achievements as stemming from a long and well-founded tradition of vision, science, and engineering.

These remarks of Y. A. Pobedonostsev, Stalin prize-winning Soviet scientist, and an early experimenter in the field of jet propulsion, emphasize that tradition and its promise of continued achievements in space. The remarks appear in exactly the same form in which they appeared in the U.S.S.R., and reveal considerable national pride in the achievements to date, consciousness that these achievements are thought of in some quarters as being borrowed from foreign technologies, and even some of the inevitable propaganda that finds its way into every article of this type.

Above all, however, they illuminate the solidly founded Russian background in rocketry and jet propulsion, the prime movers of space projects. This background, the successes it has helped bring about, and its promise for the future are worthy of consideration in plotting the course of our own future astronautical program.

When Sputnik I was launched on October 4, 1957, the whole world applauded this outstanding achievement of Man's genius. The press hailed it as the beginning of a new era in the life of humanity, the era of the conquest of cosmic space.

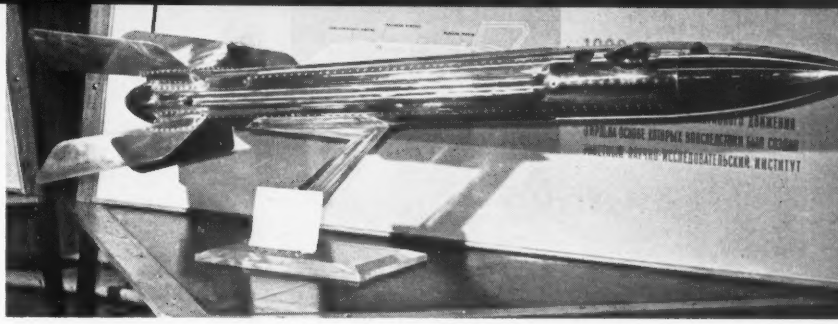
Many manmade satellites of the earth reached their orbits in the last two years. The world's first cosmic rockets are revolving around the sun, and the first guided rocket was shot up from the earth to another planet, the moon. Although the weight and equipment of Sputnik I have long been surpassed, mankind will always remember with gratitude the builders of the small aluminum globe which was the first to tear through the atmosphere into outer space.

Sputnik could not have appeared of a sudden. It has taken a large group of scientists, engineers, workers, and technicians many years of hard work to make this cosmic flight possible. We have asked the well-known Soviet scientist Prof. Y. A. Pobedonostsev, a Stalin Prize Winner, to acquaint our readers with the development of Soviet rocket engineering and to show what has made it possible for the Soviet Union to launch the world's first cosmic rocket. Here is what he told us. (Editor—Soviet press introduction to Professor Pobedonostsev's following remarks.)

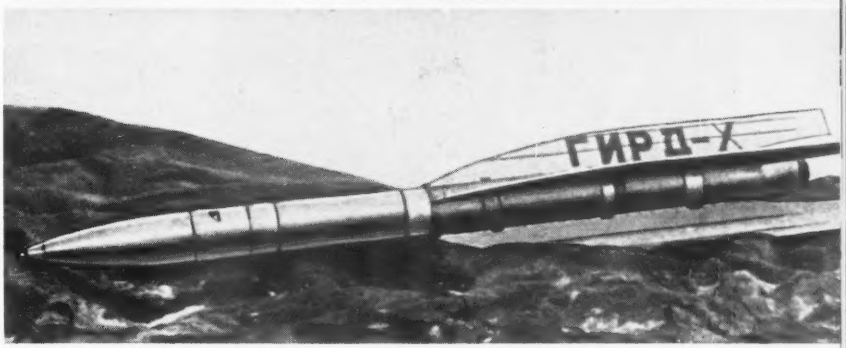
SOVIET rocket engineering is still awaiting its historians. I shall try to review in brief only some of the stages in Soviet rocket engineering which have enabled Soviet scientists to blaze the trail to unexplored worlds of the universe.

The fact that the dispatch of a flying craft to regions beyond the earth's atmosphere is possible was proved theoretically long ago by the outstanding Russian scientist K. E. Tsiolkovskii. Beginning in 1895, he was studying jet propulsion, and in 1903 he summed up these investigations in a classical work which gained him immortal fame. In this work, Tsiolkovskii proposed his project for a jet engine

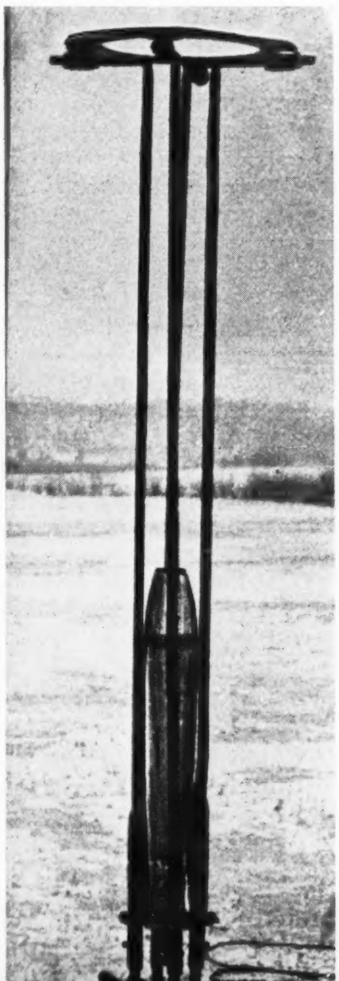
First Soviet vehicle powered by a liquid-oxidizer engine. Built in 1933, it was 245.7 cm long, 160 mm in diam, and weighed 20 kg. It rose to an altitude of 4500 meters.



GIRD-X, one of the first Russian liquid-fuel rocket vehicles, was also tested in the early thirties.



Soviet scientist I. A. Merkulov designed this experimental two-stage vehicle in 1936.



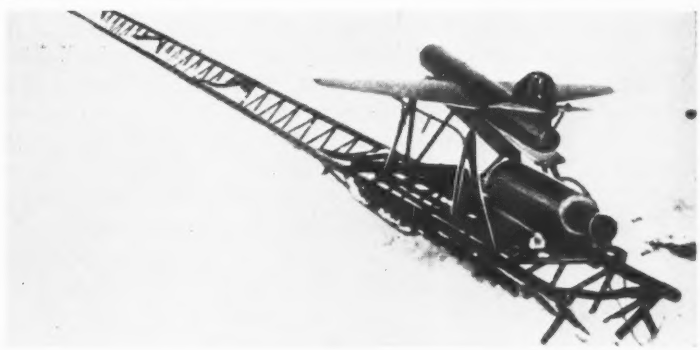
operating on liquid fuel and an oxidizer. In the years that followed, Tsiolkovskii continued and developed his theoretical investigations.

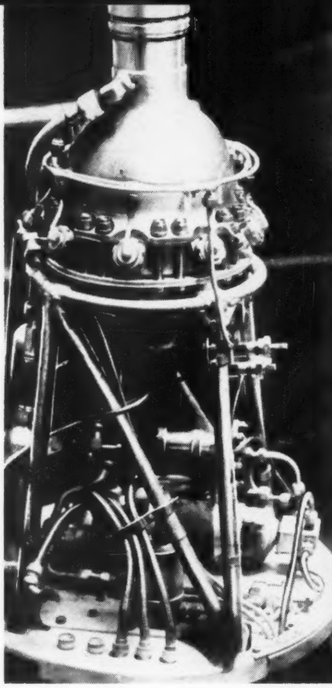
"Mankind will not remain on earth forever," he predicted. "In the chase after light and space, it will penetrate beyond the atmosphere, timidly at first, and then win for itself all the space around the sun."

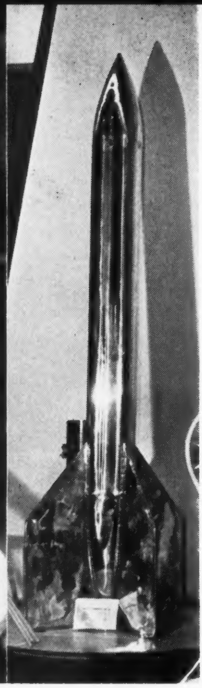
After the October Revolution, beginning in 1917, the problems of rocket propulsion also occupied the attention of Y. V. Kondratyuk. His talented theoretical work, which supplemented Tsiolkovskii's works, was published in Novosibirsk in 1929. Kondratyuk proposed the use of ozone as an oxidizer in rocket fuels and developed the idea of aerodynamically braking a rocket returning from space.

A major contribution to the theory and practice of rocket building was made by the Soviet scientist F. A. Tsander (a Lett by nationality), who began working on theoretical problems connected with rocket propulsion in 1919. In 1930, he built an original jet engine, the OR-1, which ran on gasoline and air; it passed all the tests. It

ORM-65 experimental engine, using nitric acid and kerosene, supplied power for this vehicle.







Left, RD-1, another experimental engine, looks like American engines dating back to the same period in the mid-thirties. Right, Aviavnito rocket, built in 1936, reached a height of 6000 meters. It was 322.5 cm long, 300 mm in diam, and weighed 97 kg.

was thus proved in practice that it was possible to obtain jet propulsion power with a fully satisfactory efficiency. Two years later, Tsander, together with a group of his followers, built an improved engine, the OR-2, which developed a thrust of 50 kg, quite a substantial achievement at that time. The engine ran on gasoline and liquid oxygen. Tsander also designed (in three variants) a jet engine with a 5-ton thrust and an engine with a 600-kg thrust which were intended to run on liquid and solid fuels.

Construction of the GIRD-10 rocket was started under Tsander's guidance. With an engine operating on liquid fuel (alcohol) and liquid oxygen, it was calculated to rise to a height of 5.5 km. With a diameter of 0.14 meters and a weight of 29.5 kg, it was 2.2 meters long. But Tsander did not live to see the consummation of his efforts. He died (in 1933) 10 days after the first test of the trial model.

In a letter from Kislovodsk written shortly before his death, Tsander urged: "Forward, comrades, move only forward! Raise rockets higher and higher, nearer to the stars!"

Tsander's pupils carried out his bequest. On Nov. 25, 1933, the first Soviet liquid rocket was fired. L. Korneyev, a mechanical engineer who helped launch it, recalls the following:

"The rocket was mounted on the launching pad. The tension of the people grew along with the pressure in the tanks. At last the pressure was raised to the designed magnitude. 'Contact!' was the order given in an excited voice.

"The ignition was switched on, the engine began to work, and, rising slowly and reluctantly, as it were, the GIRD-10 flew up and then, gathering speed, streaked upwards."

A trial flight of a half-liquid rocket designed by another group of scientists took place slightly earlier on Aug. 17, 1933. That was also an important landmark in the development of rocket engineering in the U.S.S.R.

Thus were the first Soviet liquid fuel rockets sent up in 1933.

Tsander, together with Tsiolkovskii and Felix E. Dzherzhinsky, are credited with starting in 1924 the Society for Studying Interplanetary Communications, first formal Soviet organization for rocket and space research.

One of the most shining pages in the history of Soviet rocket engineering is associated with the construction of the liquid fuel rocket. The most remarkable thing about this engine lies in that it needs no air or oxygen for its work. Its fuel contains all it needs for burning—both fuel and an oxidizer. The liquid jet engine can therefore work not only on the earth and in the altitudes where planes fly with air-jet engines, but also in airless space, at distances many thousand kilometers from earth.

Compact and light, the liquid jet engine is capable of developing a greater traction power than any other jet engine of the same size and weight. That is why liquid jet engines are now widely used, primarily for rockets of varying designations.

Early Propellants

As the result of theoretical investigations and experiments conducted by a group of Soviet scientists, it was possible to recommend for the first time in 1930 the use of nitric acid, nitrogen tetroxide, hydrogen peroxide, tetranitromethane, perchloric acid, and their solutions as oxidizers for liquid rocket engines. Many of these oxidizers have found extensive uses in rocket engineering in the U.S.S.R. and later also abroad.

The design for the ORM-1, the first liquid rocket engine in the U.S.S.R., was prepared in the same year at a rocket laboratory in Leningrad. Tested with liquid oxygen and gasoline, it developed a thrust up to 20 kg. A whole series of such engines for operation on kerosene and nitric acid was designed in 1933. One of them, the ORM-50, developed a thrust of 150 kg. The ORM-52, which was tested with success in the same year, developed a thrust of 300 kg.

The ORM-65 was tested three years later. It

worked on nitric acid and kerosene, the pressure in the combustion chamber being 22 atm. The engine had pyrotechnical ignition and a fuel-feed cylinder. In 1937–1939, it was tested in the RP-318 rocket plane and in a winged rocket on the ground and in the air.

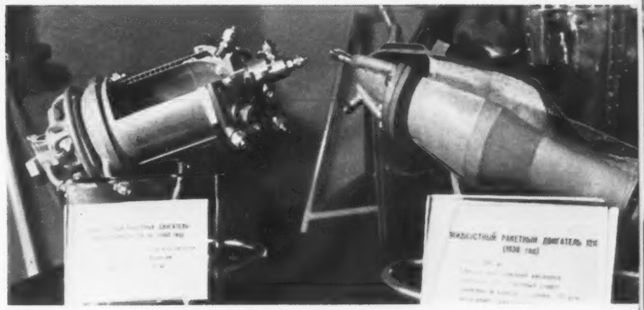
Work was conducted in the Soviet Union at the same time on the construction of air-jet motors which subsequently found wide use in jet aircraft. Young designers were learning primarily from the works of the well-known Soviet scientist, Academician B. S. Stechkin, author of the theory of these motors. I cooperated in the first experiments in this field.

Uniflow Engine for Aircraft

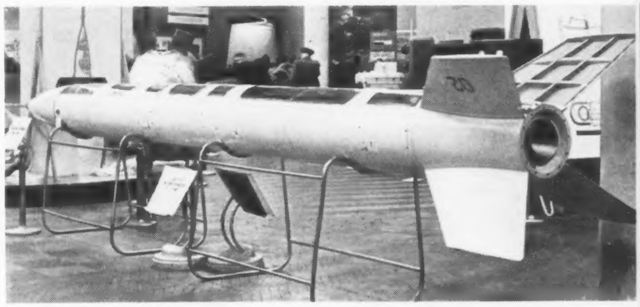
In the thirties, I. A. Merkulov undertook to design, on the basis of Stechkin's works on the theory of air-jet motors and experiments conducted under my direction, the first jet uniflow engine for a fast airplane.

Before equipping an airplane with this engine, the designer decided to test it by means of a rocket. For this purpose, Merkulov designed a trial two-stage rocket in 1936. The first stage was a gunpowder engine which was to detach itself after driving the rocket up to the required speed. A rocket with a uniflow jet engine was used as the second stage. The rocket had stabilizing aerodynamic surfaces. The first stage weighed about 3.5 kg, including the weight of the solid fuel, which was 1.079 kg. The engine of the first stage worked 8 sec at a gas-flow speed of 1860 m/sec. The second stage of the rocket weighed 3.56 kg, including 2 kg of fuel. The initial weight of the two-stage rocket was 7.07 kg.

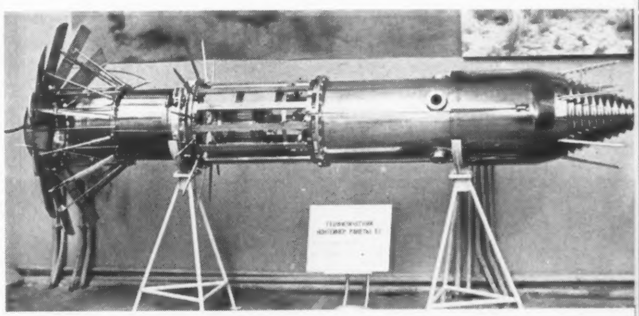
On May 19, 1939, a group of designers and engineers assembled at Station Planernaya, near Moscow, where the rocket was already mounted on the launching pad. The first stage was put into operation. Gliding up on vertical guides, the rocket detached itself from the launching unit and began to scale its vertical trajectory. (CONTINUED ON PAGE 48)



Left, kerosene-nitric acid engine providing maximum thrust of 140 kg for rocket glider. Right, the 12-K ethyl alcohol-lox engine for the Aviavnito vehicle, weighing 12 kg and supplying 300 kg of thrust.

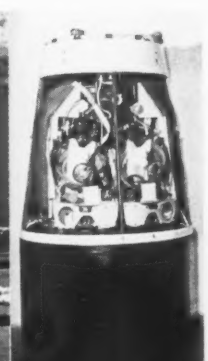


Soviet meteorological rocket, designed to carry an 80-kg payload to a 100-km altitude. Fueled with kerosene and nitric acid, its total weight is 725 kg.



Side view of the instrumentation capsule for the Soviet Model A-2 geophysical rocket. Weighing 340 kg, the capsule reached an altitude of 212 km in one flight.

Left, the 1500-kg instrumentation capsule of the Model A-3 rocket, recovered after reaching an altitude of 452 km. Right, section of Model A-1 rocket with jettisonable animal containers.



Unique meeting of East and West at ARS Annual Meeting is typified by this cordial handshake between Wernher von Braun (left) and Leonid I. Sedov, head of the Soviet delegation which attended the meeting. Scenes like these were common at the meeting. At right, Russian and American scientists talk about space while the press and photographers crowd in.

Interview with the Soviet delegation

ARS Annual Meeting provided unique opportunity for U.S. and Soviet space scientists to discuss matters of mutual interest . . . Herewith, some comments by members of the Soviet delegation at the meeting

By Irwin Hersey and John Newbauer

Richard W. Porter of GE (left), vice-chairman of COSPAR, chats with A. A. Blagonravov and V. I. Krassovsky of the Russian delegation, with an assist from V. G. Kostomarov, delegation interpreter.

THE 14TH Annual Meeting of the AMERICAN ROCKET SOCIETY was a memorable one for a number of reasons, not the least being the opportunity it provided for American space scientists to get together with their Russian co-equals for informal discussions of mutual interest.

In conversations with members of the Russian delegation—the first such delegation to attend a society meeting in this country in the field of rocketry and astronautics—American space scientists managed to uncover a good deal of information about the Soviet space program. Responses by members of the delegation to questions put to them at the two technical sessions which they attended and at an informal press conference provided additional information about Soviet astronautical plans and prospects.

What follows is a compilation of some of the more interesting comments by the Russians at the meeting.

On the general attitude of the U.S.S.R. toward space exploration: There is no question that space

exploration must and will be effected. The U.S.S.R. is fully determined to carry space exploration forward as a major national effort. This decision was made at about the time of the first Sputnik.

On funding the Soviet space program: Soviet space scientists had some difficulty convincing the nation's leaders of the need for a space exploration program prior to Sputnik I. Since that time, they have had clear sailing, with a straightforward program planned and carried out. All budget problems are discussed thoroughly, and projects of undisputed significance have always been funded.

On the goals of the Soviet space program: The ultimate goal of the program is to put man into space; this will not be attempted until there is assurance that the man can be recovered unharmed. This goal is being approached in large steps only, with each new experiment being undertaken when its chances of success appear very great and the equipment used is regarded as being completely safe and reliable. Every experiment has a scientific and technical soundness, and no attempts have been made to repeat similar experiments.

On the difference between the Soviet and American attitude toward space scientists: One member of the Soviet delegation used the analogy, in discussing this point, that American scientists drive their own cars while Soviet scientists have chauffeurs. Thus the Americans are concerned with how they are going to get somewhere, rather than with the goal they are aiming for. In Russia, he noted the scientists concentrate on what they know best—space exploration. They do not have to justify their own work or worry about funding their projects, since the government does it for them. "And this," he noted, "is why we hit the moon first." Scientific

Left to right, George Sutton of ARPA, former ARS president; Leonid I. Sedov; and ARS board member A. K. Oppenheim of the Univ. of California.

thinking, he added, is much the same in the two countries.

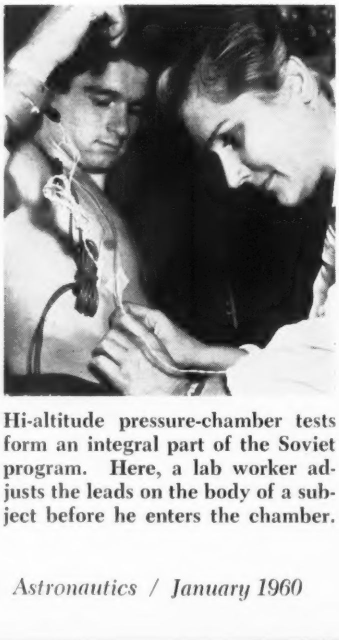
On U.S. space achievements: The Soviet space scientists had nothing but praise for U. S. accomplishments to date, and saw still greater accomplishments in the future. On a visit to the ARS Astronautical Exposition, the delegation seemed quite impressed with many of the exhibits, spent a good deal of time at the G. T. Schjeldahl display of inflatable plastic balloons for rocket and satellite launch and at the Avco exhibit.

On U.S.-Soviet cooperation in space experiments: The question of a joint U.S.-U.S.S.R. space project is of great import to scientists in both countries. The Russian delegation had discussed this with NASA, and both parties agreed that joint work is possible and advisable. Also, both parties realize that a step-by-step approach must be taken toward such a program. (CONTINUED ON PAGE 66)

From left, Abe Silverstein of NASA, V. I. Krassovsky, Leonid I. Sedov, and V. G. Kostomarov of the Russian delegation. At right, Americans peek at Soviet photos of the far side of the moon, on display at the meeting.

Soviet man in space

A transcript of the question-and-answer period which followed the showing of films on Russian biological experiments at the ARS 14th Annual Meeting and produced some valuable information on their program



Hi-altitude pressure-chamber tests form an integral part of the Soviet program. Here, a lab worker adjusts the leads on the body of a subject before he enters the chamber.

WITH Project Mercury hotting up, no subject has been more open to speculation and guesswork than the present status of Soviet work on man in space. The Russians, as always, have been silent on their intentions in this area.

This silence was broken, at least to a certain extent, at the ARS 14th Annual Meeting in Washington, where Professor Anatoly A. Blagonravov, a member of the Soviet delegation which attended the meeting, showed a new Russian film on weightlessness experiments and agreed to answer questions from the floor about the film and about the Soviet man-in-space program.

The partial transcript of this question-and-answer period which follows does not tell us everything we would like to know about Soviet efforts in this area. However, it does provide us with a prominent Russian's view of his country's program and the shape it is taking. Answers to questions were given through an interpreter.

—I. H.

Q: I would like to ask Dr. Blagonravov if this film we have just seen is available to companies on a loan basis and, if so, how?

A: Yes, the Professor thinks it's quite possible to obtain the film (through the Russian Embassy).

Q: Since there was a series of sequences in the film, what was the calendar time, say, covered by this series of sequences?

A: 1951 to 1957.

Q: Would the Professor describe the booster vehicle? (Audience laughter.)

A: There were a number of types of rockets used for this experiment. Well, you've seen the first one with pressurized cabin.

Q: I'd like to ask whether the reaction of dogs to non-normal atmospheres, for example, pure oxygen at low pressure, is about the same as that of human beings.

A: Well, you see, Professor Blagonravov was in charge of all experiments carried, and, of course, there were a number of people responsible for different types of experiments. People from the Academy of Medical Sciences were actually in charge of this (part of experimentation). His answer as an amateur (on this point) is, he thinks the reactions are very similar.

Q: Did the measurements on the dogs indicate physiological adaptation to the weightlessness?

A: Apparently, yes.

Q: In light of the animal experiments, as demonstrated here, we would like to ask the Professor if he would speculate on the status of the man-in-space program in Russia.

A: Well, Professor Blagonravov thinks that, technically, this flight is quite possible now, if we take into account the possibilities the Russian scientists have right now at their disposal. But he thinks that such a flight should be carried out only when

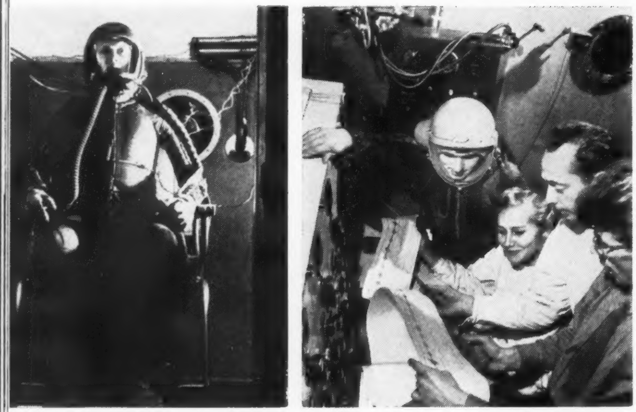
A technician supplies some last-minute instructions before the "flight" begins.

certain conditions are fulfilled, and these conditions are, when there will be absolute safety for man in this flight; secondly, when the system for his return back will be quite safe; and thirdly, when we really will have some tasks which this man should perform, and which could not be performed by automatically controlled instruments. (Applause.)

Q: Would the professor try to predict what tasks their astronaut would be expected to perform?

A: Well, it's rather difficult to discuss this question right now, because all the tasks which the Soviet scientists put before themselves now could be solved by means of automatically controlled devices; but if they will encounter a task which

The subject examines some of the equipment inside the chamber as the test gets underway.



Dressed in a partial-pressure suit and helmet, the subject is shown left at altitude. Right, safe on the "ground" once again, the subject and lab workers examine records of the test.

Animals are also being used extensively in Soviet biological experiments. Above, lab worker dresses a dog for a test while a rabbit waits its turn. Below, test dog Tziganka, returned from a flight in the chamber, gets a little coddling from technicians.

couldn't be solved in this way, then the question about the manned rocket will arise.

Q: Could the Professor describe a little more clearly and more in detail the air-regenerative system that was used during the flight?

A: A rather usual system was used for air regeneration, consisting of some chemicals through which air was passed by means of a fan. (This was to be described in Professor Blagonravov's paper next evening.)

Q: Professor Blagonravov, was there evidence of radiation damage to these dogs, as indicated perhaps by delayed physiological change?

A: Nothing was established on these dogs which could be explained by the fact that these dogs were subjected to the radiation only for a very short time. We must remember Laika in the satellite. In that case, they didn't establish any considerable effect on her health by the radiation.

Q: I understand that, maybe for a year, or possibly two years, Russia has had a series or a group of astronauts in training similar to our own. First of all, I'd like to know if this is true, and secondly, if it is, what is the object of their training?

A: This information comes from—you know, is ungrounded and comes from newspapermen. (Laughter.)

Q: Were any of these (animal-carrying non-satellite) flights after Sputnik II, and if they were . . . do they indicate problems for the future for longer periods, beyond the 24 hr, as far as the biological specimen is concerned?

A: The experiments on the behavior of animals (in flights) longer than those shown in the film were carried out only in Sputnik II on Laika, and the results are published and are now translated and are available in No. 10 (the October 1959 *ARS Journal*).

Q: There weren't new changes or anything?

A: No, nothing.

Q: Did the Professor actually say, as reported by a West German newspaper, that two men and two women were launched to a lunar flight and not recovered and there was an attempt to rescue them; or that such a flight was proposed and its problems anticipated? Or was he misrepresented?

A: Well, Professor says this is not the first time that a newspaper launched a fairly tale, and he says there was something of this kind published in Liberia in a magazine, and the Liberian magazine, well, asked the Professor's pardon later on, which was not the case with this Dusseldorf newspaper.

Q: Does the Soviet Union have a man-in-space program, and would he predict when such an effort would get underway?

A: They haven't got a program like that. The only thing they have is the program of research on safety of the flight. (CONTINUED ON PAGE 74)

ARS plans "Spaceflight Report to the Nation"

To be held in the New York Coliseum Oct. 9–13, 1961, the week-long meeting-exhibit will be the largest ever in the field of astronautics

ARS has announced plans for the largest meeting ever scheduled in the field of astronautics, to be held at the New York Coliseum Oct. 9–13, 1961.

To be called the ARS "Spaceflight Report to the Nation," the week-long meeting will use all four floors of the mammoth New York show place in an unprecedented chronicling of the many-faceted field of astronautics.

Included will be three floors of exhibits, highlighted by a National Aeronautics and Space Administration display depicting man's progress into space. The Department of Defense similarly will have a graphic exhibit of the contribution it has made to astronautics.

About 500 organizations are expected to display their space wares in the giant exposition, which will cover some 220,000 sq ft of floor space.

The exhibits will be open to the profession and attendees of the technical sessions, and at specified times to the public. Organized visits by school and university groups are under consideration. Special films and lectures will be held for the public.

300 Papers to Be Presented

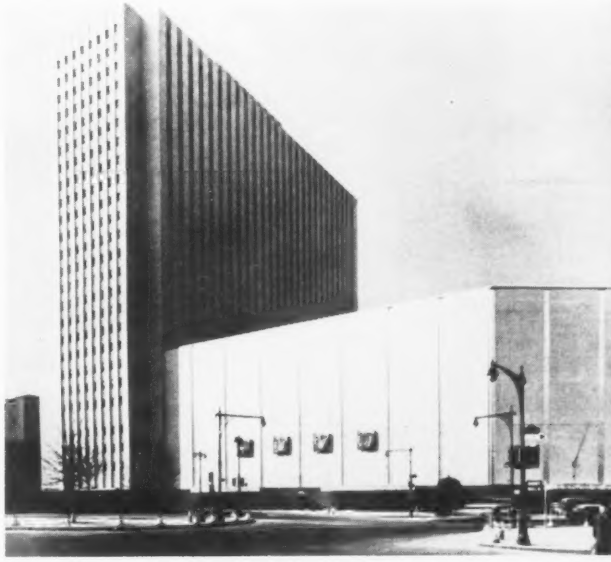
The technical sessions will present some 300 papers and will be held on the fourth floor in five specially-built soundproof meeting rooms. The papers will cover all the disciplines of astronautics, including space propulsion, guidance and navigation, space-vehicle logistics and operations, astrodynamics, magnetohydrodynamics, hypersonics, and others.

Col. John P. Stapp, 1959 president of the Society, in announcing plans for the meeting, said ARS decided to schedule it because:

"Today, the Society's responsibility for spreading new technical information to its 15,000 members is augmented by a need to help translate this information into the vernacular of the lay citizen.

"The citizen's 'need-to-know' comes from paying the taxes that support the greater part of astronautical and missile research and development, and from the adjustments he must make to its effects on his way of life. Even more imperative is the responsibility to educate coming generations, not only to recruit replacements in a growing frontier of science, but to assure sympathetic support from enlightened citizens oriented to accept progress." ♦♦

New York Coliseum, scene of the mammoth ARS "Spaceflight Report to the Nation," scheduled for Oct. 9–13, 1961.



Von Kármániana—Part II

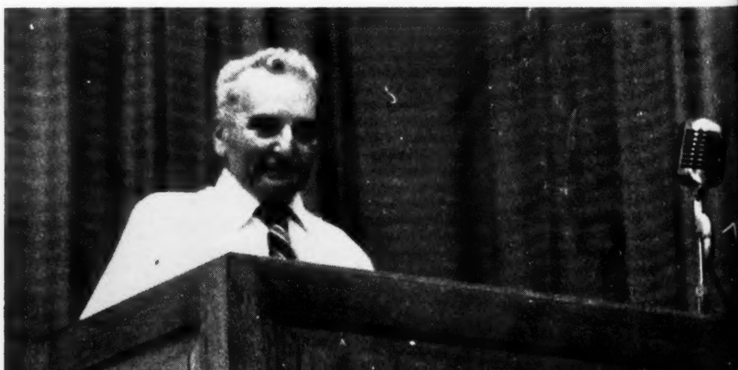
A second treasury of witticisms, quips, and anecdotes by the Master

By Lee Edson and A. K. Oppenheim

A year and a half has passed since we first proposed the compilation of a treasury of the humor of Theodore von Kármán. In the foreword to the first installment, published in the June 1958 Astronautics, we noted that further contributions would be welcome. Our hope was that in this way von Kármán's amusing quips and anecdotes would not only be preserved in written form for all to share, but would also become a living testimonial to the human and colorful side of the Master.

This second installment of "Von Kármániana" indicates that the response has been very heartening—indeed, that the gold mine of Kármán witticisms runs much deeper than even we ourselves had anticipated. To all those who have sent in Kármán anecdotes, we would like to extend our thanks. We hope that contributions of this type will continue to flow and, as before, ask only that the stories have a mark of authenticity, including, if possible, the time and place they were told—and, of course, that they be printable.

THIS second installment of von Kármániana properly begins with the now-famous story which von Kármán likes to tell whenever he starts an after-dinner talk—as was the case at the 1958 Heat Transfer and Fluid Mechanics Institute at Berkeley. In the days when the Romans were persecuting Christians, the Emperor held a huge circus, the highlight of which was to be the slaughter of Christians by lions. Thousands of people turned out to see this event, amid considerable fanfare. Finally the Christians were re-



. . . at the rostrum

leased into the arena and the first lion sent after them.

However, as the spectators rose to watch the spectacle, a strange thing happened. The leader of the Christians boldly walked forward to the lion, bent over his ear and whispered something. The lion thereupon promptly backed off and lay down. The Emperor was astounded. He called the Christian leader to the dais.

"What in the world did you tell that lion that prevented him from eating you?" the Emperior demanded.

The Christian remained silent. Then he said, "I'll tell you if you promise to let me and the other Christians free."

The Emperor, consumed with curiosity, impatiently agreed. "All right," he said, "now tell me, what did you tell that lion?"

"All I said," the Christian replied, "was that, after the meal, he'd have to say a few words."

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A university administrator, who wishes his name withheld, tells us the following story about Kármán's early days at CalTech. In the early thirties, CalTech required an oral examination of every Ph.D. candidate. One candidate prepared to start at 1:30 p.m. before an examining committee whose chairman was Kármán. At the appointed time, however, Kármán was nowhere in sight, and the rest of the committee decided to go ahead without him.

About a half-hour later a note arrived saying Kármán was lunching with Will Rogers and would arrive later. At 3:30 p.m., when Kármán still hadn't shown up, the committee phoned him. His instructions were to keep the candidate busy until he got there. The committee took him at his word and kept firing questions at the unhappy candidate. At 5 p.m., they decided Kármán wouldn't arrive at all and the candidate was dismissed.

The next morning he appeared in Kármán's office, fully expecting to undergo the ordeal of a personally conducted examination. Kármán greeted him: "Congratulations. I understand from the committee that you did an excellent job. Where do I sign?"

° ° °

A Westinghouse executive (George F. Gayer of Sunnyvale) sent us the following addition to the von Kármán Devil's Dictionary: "In July 1946, I flew to Europe on business with John McCone, then head of Joshua Hendy Iron Works. Kármán was also a passenger on our plane, as he was going to present a paper at and receive honors from the French Academy. As we were walking along the boardwalk from the airport building, he asked me if I knew the definition of an aerodynamicist. I said "no."

"An aerodynamicist," said Kármán with a twinkle in his eye, "is a man who is willing to assume everything except responsibility."

° ° °

At the MIT Combustion Symposium in 1952, Melvin Gerstein of NACA was delivering a paper on the ethylene oxide decomposition flame. In the paper, he mentioned that his colleagues saw no visible light associated with the flame, while some English workers had reported the flame was blue. A preceding paper by Ray Friedman, then with Westinghouse in Pittsburgh, indicated the flame was light gray. On hearing this, Kármán turned to the gentleman sitting next to him and laughed.

"I have solved the problem," he said. "In England, there is much fog and so the investigators see a blue flame; in Pittsburgh, it is smoky so the flame looks gray; and, in Cleveland, it is clear so they see nothing."

° ° °

Dr. Gerstein, now of NASA, reminded us also about the incident that (CONTINUED ON PAGE 44)

. . . receiving honors

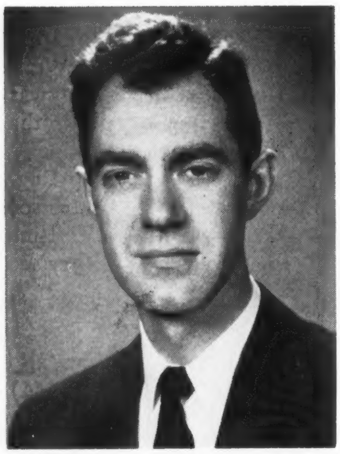
. . . in a pensive mood

Rocket morphology and nomenclature

Modern rocketry poses a formidable nomenclature problem in distinguishing among various vehicle classes and systems

By Henry Burlage Jr.

CASE INSTITUTE OF TECHNOLOGY, CLEVELAND, OHIO



Henry Burlage Jr. joined the staff of Case Institute in 1952, and is now director of its Propulsion and Aerodynamics Laboratory, responsible for graduate and undergraduate courses in jet propulsion, internal combustion engines, and aerothermodynamics. Prof. Burlage has consulted and done research on instrumentation techniques and combustion, as well as on specialized industrial problems. During the 1958–59 academic year, he was an NSF Science Faculty Fellow at the Engineering Laboratory of the Univ. of Cambridge, England. He taught at Rensselaer Polytechnic Institute from 1945 to 1952, and during WW II was a forecasting officer and commander of a base weather group with the USAF.

IN THE broad sense, a rocket "motor" is any one of a whole class of possible propulsion devices that produce thrust because a material (which will be called the propulsive substance) originally contained within the apparatus is, in some way, energized (even to the point of converting it to radiation) and then ejected.

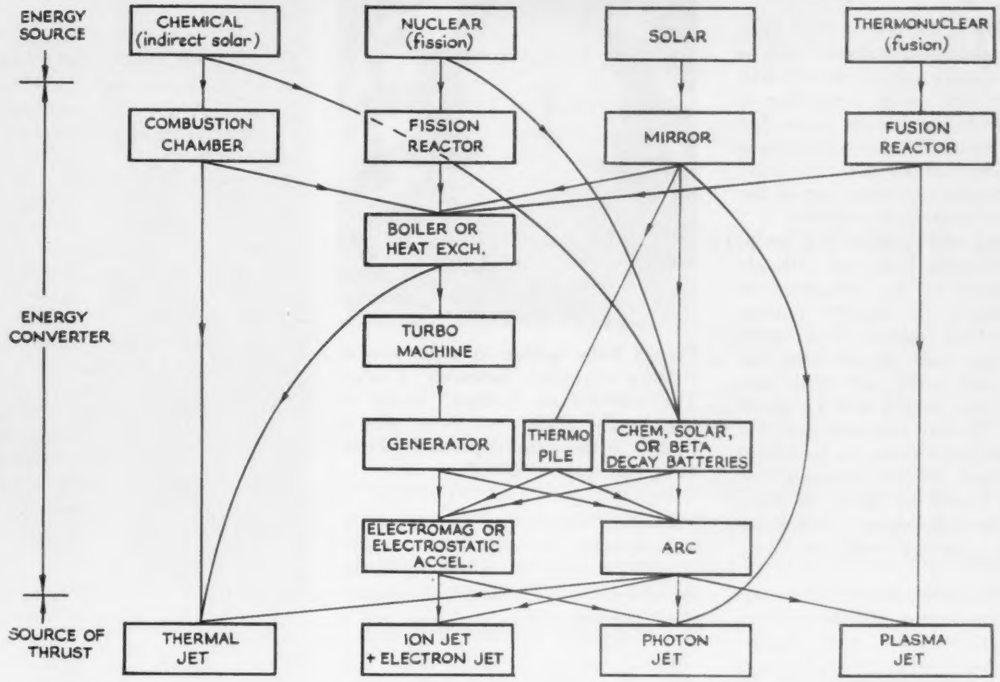
In general, however, the modern "rocket" is no longer a "motor" in the classical sense, which implies a more or less self-contained entity. Instead, it is a system consisting of (1) an energy source, (2) an energy converter (or converters), (3) a propulsive substance, and (4) a thrust generator.

Undoubtedly, the reader will note that the word "rocket" has been used to imply the propulsion device only. A digression is necessary to argue this point. Historically, and by the usual dictionary definition, a rocket is implied to be the entire apparatus: Vehicle, payload, and propulsion device of the type described above. Consider, though, the variety of such propulsion devices that seem possible today, and further, the number of purposes, usually determined by the payload, to which the vehicles are put. It seems futile to call each and all of these complexes "rockets." Therefore, the word rocket should be reserved as the name for any member of the category of propulsion devices previously described. The vehicles, then, could be "rocket-propelled ballistic missiles," "rocket-propelled guided missiles," "rocket-propelled atmospheric sounding devices," "rocket-propelled space probes," and, optimistically, "rocket-propelled space vehicles." In none of these examples is there an indication of the kind of rocket—only the fact that propulsion is accomplished in a special way.

What's in the Name?

To return to the main point of the discussion, it must be recognized that rocket systems (referring now only to the propulsion device) whether simple, in the sense that a great deal of machinery is not directly involved, or complex consist of the elements listed above. The elements can be treated, in principle if not in fact, as separate components and various types of these components can be arranged into whatever combination a selected system dictates. This idea is expressed schematically for some possible elements and arrangements in the diagram opposite. The propulsive substance is implied in the "source of thrust," the initial nature of the propulsive substance not being included because of the added complexity.

Morphology of Some Possible Rocket Systems



Unfortunately, in practice the approach is not so clearcut for systems where the energy source and propulsive substance involve the same materials. Such "consolidated" systems must be treated as more or less complete entities because of the intimate interactions between the energy release and conversion processes.

Probably the basic distinction between various systems is whether or not the energy source and propulsive substance involve the same material. This is essentially the crux of the rocket problem, particularly for spaceflight. Most chemical energy systems are the "consolidated" type since the materials taking part in the energy-release process also make up the propulsive substance. Such systems are limited by the selection of media that are satisfactory for the numerous requirements that are imposed. Further, the sources of such media are probably restricted, at least initially, to the earth since high-energy fuels and oxidizers are not readily available in the natural state. These factors as well as the possibilities of improvement in energy concentrations and release rates and the possible use of semipermanent or permanent energy sources increase interest in the separated energy-propulsive substance systems.

Among the systems that are depicted in the diagram at top, the more apparent and probable are those using existing knowledge and technology, while the systems that most excite the imagination are unfortunately now only in the realm of possibility. A variety of other methods, for example "antigravity propulsion," have received conjecture. These have not been considered as rockets because there is, to the ken of this author, little or no basic knowledge upon which to initiate a schematic design.

Naming Is a Problem

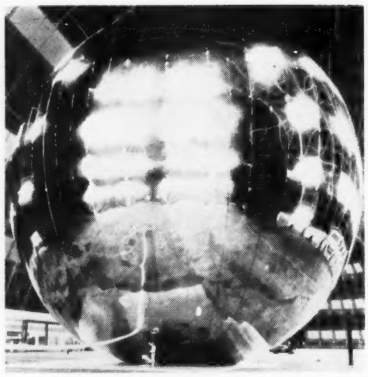
The problem of naming the various systems is a matter of some difficulty. Many of the systems illustrated in the diagram at top have received attention in the literature, but there is already much ambiguity from paper to paper as well as a decided lack of explicitness with respect to the names used. For example, it might seem that "liquid-propellant rocket" would be an adequate name, but in the light of the possibilities, this could be ambiguous if it is considered that the propulsive substance is a liquid and that the energy source used to impart the "vis-viva" is, say, a nuclear reactor. This certainly is not what is today considered a liquid-propellant rocket. The name "nuclear rocket" is equally poor since it does not state or (CONTINUED ON PAGE 75)

Get Ready for Project Echo

Launching of the first of three Project Echo inflatable spheres into a 1000-mile-altitude earth orbit will take place early this spring, according to NASA, which for Project Echo has broken policy of not announcing shoots in advance so that scientists the world over will prepare to make use of the passive-communications satellite.

The launch will be made in a northeasterly direction from the Atlantic Missile Range at an inclination of about 50 deg to the equator, putting the 100-ft-diam sphere in an orbit that will pass over all countries between 50 deg north and south latitudes. Orbital period will be about 120 min. For any one pass over the U.S., the satellite will have a maximum time of mutual visibility between East and West Coasts of about 16 min. The satellite will appear visually as bright as a zero-magnitude star (e.g., Vega).

The Project Echo sphere will be an inflatable structure of 0.0005-in.-thick Mylar plastic, coated with vapor-deposited aluminum to give radiowave reflectivity of at least 98 per cent up to frequencies of 4000 mc/sec. Although a huge balloon, it will weigh only 150 lb. Vaporization of 4 lb of water carried inside the sphere will inflate it.



Project Echo sphere in a dry run at NASA's Langley Research Center. The 100-ft-diam balloon, made of Du Pont's Mylar polyester plastic coated with vapor-deposited aluminum, tips scale at 150 lb.

Project Echo is NASA's first step in a long-range investigation of earth satellites for global communications. Its field station, JPL, through the Goldstone tracking station in Calif., and a Bell Telephone Lab station at Holmdel, N.J., will be involved in NASA's own experiments with the Echo sphere. Goldstone will transmit a 2390 mc/sec signal for interception at Holmdel. The Bell station will transmit a 960 mc/sec signal to be picked up by Goldstone.

New NBS Dead-Weight Machines for Rocket Testing

Dead-weight machines of 300,000- and 1-million-lb capacity, designed for the National Bureau of Standard's new location at Gaithersburg, Md., will greatly expand the Bureau's ability to calibrate large-force measuring instruments, such as the load cells for new rocket static-testing stands. Its previous equipment, installed in 1931, had a capacity of 11,000 lb.

Von Kármániana

(CONTINUED FROM PAGE 41)

occurred at the Liège Colloquium in 1955 in the course of the most formal social event—the Mayor's reception. The Mayor, speaking English, said he would give his remarks in French since his English was not very good. Kármán replied that the mayor need not be concerned. His observations of AGARD meetings, he went on, would indicate that the official languages of AGARD are "broken English and broken French."

° ° °

A Hungarian friend of our Great Hungarian, George C. Szego, of Space Technology Labs, reports this story. One day in Washington, D. C., in the spring of 1957, Kármán was discussing a telephone call he received that morning from the BOAC ticket office. It seems he was flying to Europe the next day. Apparently confused over the reservations, BOAC was inquiring whether his ticket was first class or deluxe. Kármán inquired about the difference.

"For the deluxe extra fare of $70 you get a special steak dinner," the voice on the other end of the line explained. "And the craft has an extra stewardess."

"In that case book my ticket for first class," Kármán replied quickly. "My doctor forbids the one and I am too old for the other."

° ° °

Rolland A. Willaume, director of the International Exchange Program for AGARD, tells us a favorite Kármán story about a digital computer which was programed for language translation.

In the course of a demonstration, the spectators were asked to propose a sentence for translation into any language. Somebody suggested the proverb: "Out of sight—out of mind" and someone else—to make the task really formidable—asked that it be translated into Chinese. The request was executed and the answer displayed on the screen. . .in Chinese characters. Everybody was quite impressed, except that—as it turned out—there was no one present who knew Chinese.

After momentary consternation an ingenious idea was proposed: Translate this back into English! The demonstrator pushed a button, everybody held his breath, the machine was visibly responding to the command, and —after a while—the result appeared on the screen. It read simply: "Blind Idiot."

° ° °

At the ARS-Northwestern Univ. Gas Dynamics Symposium last August, Kármán, who was delivering the introductory paper, was introduced by Milton Clauser, a former Kármán student. In his introduction, Dr. Clauser made reference to Kármán's Hungarian accent, and this naturally reminded the Master of a story.

It seems that a Hungarian friend of his, a zoologist named Brassai, was to be honored with a British Royal Society Fellowship. In preparation for the event, Prof. Brassai spent long months going over his acceptance address in an effort to make sure his pronunciation would be letter-perfect. The great day came and Prof. Brassai delivered the address he had practiced so carefully.

At the conclusion of the address, Kármán recalled, the president of the Society arose, thanked the professor, and then remarked: "You know, it's amazing how close some of those Hungarian words are to English."

° ° °

At a meeting of the *Astronautica Acta* Committee of the IAF during the 10th International Astronautical Congress in London last September, the subject of book publishers arose. *Astronautics* Editor Irwin Hersey relates that Kármán was reminded of a staid British publisher who came to call on him regarding the contemplated publication of his collected papers. In attempting to learn a little about the publisher's *bona fides*, Kármán asked the publisher what other authors the firm had published. "One of our authors," the publisher replied, "was a certain William Shakespeare."

♦♦

One of a series

Resolving the driver-car-road complex

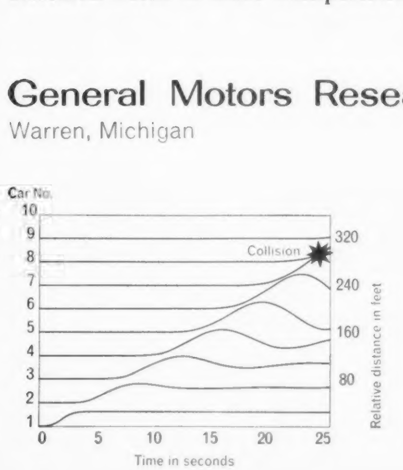
The manner in which vehicles follow each other on a highway is a current subject of theoretical investigation at the General Motors Research Laboratories. These studies in traffic dynamics, coupled with controlled experiments, are leading to new "follow-the-leader" models of vehicle interaction.

For example, conditions have been derived for the stability of a chain of moving vehicles when the velocity of the lead car suddenly changes — a type of perturbation that has caused multiple collisions on modern superhighways. Theoretical analysis shows that the motion of a chain of cars *can be stable* when a driver accelerates in proportion to the relative velocity between his car and the car ahead. The motion is always unstable when the acceleration is proportional only to the relative distance between cars. Experimentally, GM Research scientists found that a driver does react mainly to relative velocity rather than to relative distance, with a sensitivity of reaction that increases with decreasing distance.

Traffic dynamics research such as this is adding to our understanding of intricate traffic problems — what causes them, how they can best be resolved. The study is an example of the ways GM Research works to make transportation of the future more efficient and safe.

General Motors Research Laboratories

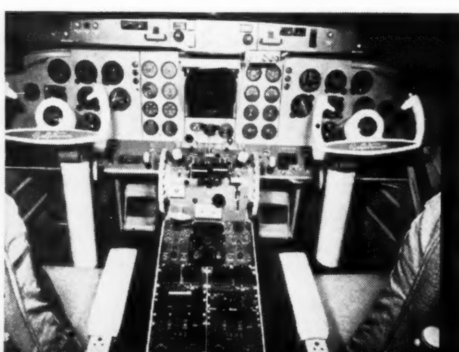
Warren, Michigan

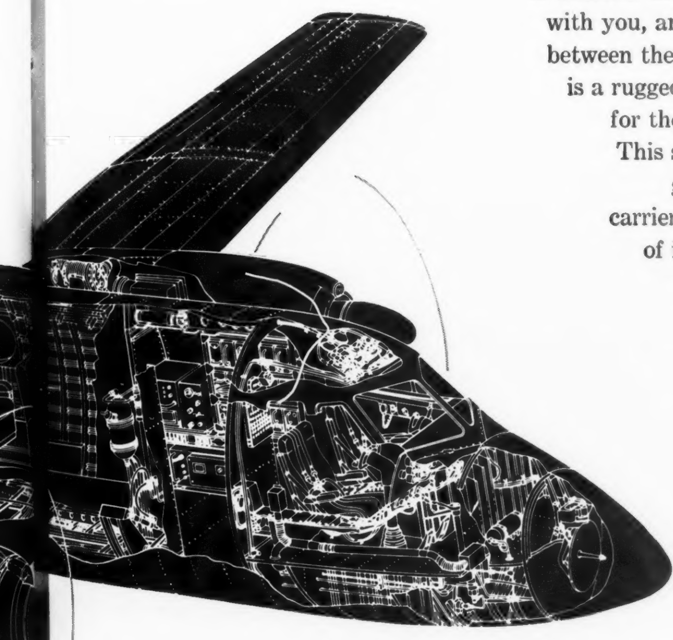


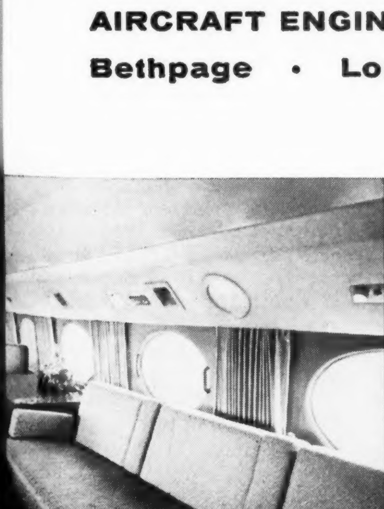
Relative positions of 10 hypothetical cars after lead car goes through maneuver. Amplitude of instability increases, resulting in a collision between 7th and 8th cars.

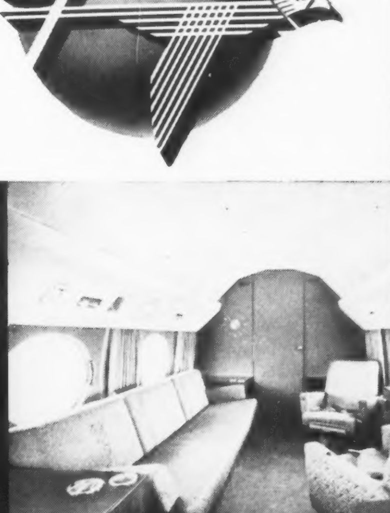
YOU ARE INVITED to inspect the Gulfstream and arrange for demonstration flights through one of the following distributors: Atlantic Aviation, Wilmington, Delaware; Southwest Airmotivé, Dallas, Texas; Pacific Airmotive, Burbank, California; Timmins Aviation, Montreal.

Instrumentation, including the most up-to-date and sophisticated communication, navigation and radio equipment, is custom built into the Gulfstream by these distributors. Custom cabin interiors are fitted to customer specifications. Illustration shows how one Gulfstream owner decorated the aircraft's interior.









High Voltage For Satellites

High voltages can be generated for satellite operations by the ferroelectric converter, a new development of ITT Labs. Unlike the solar cell, which depends on incident light to produce direct current at low voltage, the new converter requires only temperature changes to give a high-voltage alternating current. ITT engineers have been able to obtain an output of more than 1000 volts with a single converter element the size of a dime. Elements in series can theoretically produce outputs near a million volts. The ferroelectric converter was announced by ITT at the ARS 14th Annual Meeting.

ITT engineer Sigmund R. Hoh holds a satellite mockup illustrating what the company sees as a typical application of its new ferroelectric conversion system. Dark panels are conversion elements.

Behind the Luniks

(CONTINUED FROM PAGE 33)

It returned later, after fulfilling the given program for the flight.

Parameters of the trajectory were determined by means of optical instruments by scientific workers of the Moscow Planetarium. An analysis of the data on the flight revealed that the engine of the second stage of the rocket developed a substantial traction.

The success of the experiment encouraged the enthusiasts of rocket engineering and furnished the ground for the construction of a uniflow jet engine.

In the same year (1939), Merkulov prepared several designs for airplane jet motors—cigar-shaped tubes with a diameter of 400 mm, a length of 1500 mm, and a weight of 12 kg. The fuel for these engines—gasoline—was heated in the engine and injected into the combustion chamber in vapor state. Two such engines were mounted on the I-15 fighter designed by N. N. Polikarpov. They were placed under the wings.

On Jan. 25, 1940, an official commission for the tests testified to the birth of a new aircraft jet engine. On that day, a plane piloted by test pilot P. E. Loginov took off at the Frunze Central Airdrome and picked up the required altitude. Observers on the ground could see two bright torchlights under the plane's wings. Those were the world's first uniflow jet engines for aircraft in operation.

After flying several circles over the airdrome, the pilot tested the engines and, working up their intensity, stepped up considerably the speed of the flight.

Forecast Comes True

After Loginov, other pilots also made testflights in planes with uniflow jet engines. These motors were later tested on I-153 (Chaika) fighters designed by N. N. Polikarpov and on the Yak-7 designed by A. S. Yakovlev. The tests were successful and showed that a new and reliable jet engine with a great future in aviation had been called into being.

Practical tests of uniflow engines in flight were started outside the U.S.S.R. later.

Consequently, the launching of Merkulov's rocket on May 19, 1939, was the first practical step in the creation of uniflow jet engines and one of the first in the construction of composite two-stage rockets.

As K. E. Tsiolkovskii had forecast, multistage rockets can work up high velocities. They are now used in the overwhelming majority of known projects for spaceships.

Thus was it possible to lay in the thirties the basis for Soviet jet propulsion engineering, without which the development of fast Soviet aircraft and the subsequent cosmic rockets would have been unthinkable.

Shortly before his death, on May 1, 1939, the renowned author of the theory of rocket engineering, K. E. Tsiolkovskii, could say with full justification:

". . .Now, comrades, I am firmly convinced that my other dream, interplanetary flights, which I have substantiated theoretically, will also come true.

"I have been working for 40 years on the jet engine and thought that an excursion to Mars would begin only many centuries hence. But times change. I believe that many among you will witness the first transatmospheric voyage."

Work on the construction of jet engines was carried on uninterruptedly during the war years. The RD-1, with a thrust of 300 kg and ether and air ignition, was tested officially in 1943. It worked on nitric acid and kerosene fuel with a pump feed. An improvement was the modified model of this engine with similar hauling power but chemical ignition, the RD-IX3.

At the traditional air display in Tushino, on Aug. 18, 1946, the spectators watched S. A. Lavochkin's plane fitted with an RD-IX3 liquid jet engine sweep over the airdrome in the concluding performances.

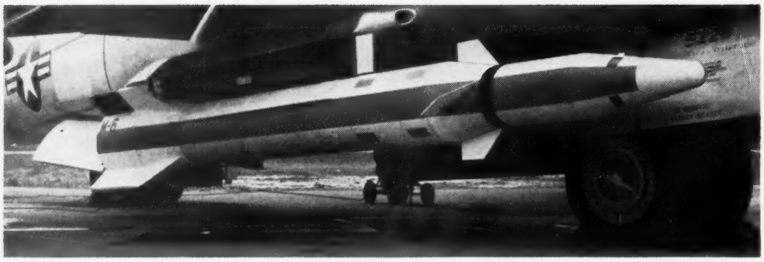
The work done by a large group of Soviet scientists, engineers, technicians, and workers led later to the construction of very light and powerful engines which have made it possible to launch the latest rockets on their spaceflights. However, credit for the success is due not only to rocket engineering. It was necessary to build a light and enduring rocket with a reliable control system. Last but not least, it was necessary to provide compact and light sources of energy to prepare the instruments for communication and transmission of the recordings by wireless, as well as the automatic scientific instruments controlled from a distance which would operate for a long time during the flight.

All these complex and fundamentally new scientific and technical problems were solved successfully. Soviet scientists have built many types of rockets.

Scientific Rocketry

Rockets equipped with scientific instruments have been sent up in the U.S.S.R., beginning in 1949, as one of the basic means for sounding the upper regions of the atmosphere. The first rocket to make a vertical ascent was launched in May 1949, to an altitude of 110 km. Other rockets of the same class were fired later. The scientific equipment sent up on the first rockets weighed 120–130 kg.

As the program of scientific investigations was steadily widened, the rockets received new equipment. A long step forward was the rocket fired to an altitude of 212 km in May 1957, with experimental equipment and a general weight of 2200 kg. As usual, the scientific equipment and test ani-



Missile Launched at Satellite

This two-stage developmental Air Force missile, the ALBM 199B, built by Martin-Baltimore, was launched from a B-47 aircraft Oct. 13 over the Atlantic Missile Range near Cape Canaveral into the vicinity of the Explorer VI satellite as it swept by in orbit. According to Martin, the firing was made to check guidance-system accuracy at approximately vertical exit angle. The photo shows the ALBM 199B on the B-47 shortly before it took off for the test.

mals were safely returned to the ground.

However, the most outstanding achievement of the Soviet rocket builders in the postwar period was the intercontinental ballistic missile. The first Soviet superdistance, multistage ICBM was sent up in August 1957, to an altitude never reached by any other flying craft before. After covering a huge distance in a short space of time, the rocket reached the intended destination.

That rocket made it possible to launch Sputnik I about a month later.

The achievements of the Soviet scientists which have ushered in a new era in world science are not accidental. They were prepared by the general development of the socialist society, and by its economic, cultural, scientific, and technical progress. They rest upon the high level of the heavy industry, precision engineering and instrument industry, radio-electronics, automatic and calculating engineering, physics, chemistry, mathematics, mechanics, and many other fields of science and technology. They stem from the very nature of the socialist system, which is based on strictly scientific principles and which has created the most favorable conditions for the work of design engineers and for the progress of engineering.

The efforts of some Western newspapers and magazines to create the impression that German specialists played an important, and even a paramount, role in the construction of Soviet rockets, seem strange, to say the least. It is well known that the most prominent German rocket builders have been working since the war in the U.S.A. and not in the U.S.S.R.

Wernher von Braun, the chief designer of the V-2, Walter Dornberger, Krafft A. Ehricke, Hermann Oberth, one of the founders of the theory of rockets, and many other German specialists in rocket engineering were taken to the U.S. after Germany's defeat. Hundreds of V-2's, as well as technical and scientific documents connected with radio-controlled equipment, were shipped from Germany to the U.S. during and after the war.

The use of German scientists and the results of their research have saved tens of million dollars and several years of research for the U.S.A. Notwithstanding this, and the American leaders themselves admit it, the U.S.A. lags far behind the U.S.S.R. in rocket engineering.

When the Soviet scientists sent up Sputnik II with Laika, the first cosmic traveler, while American rockets were exploding one after another, failing to thrust even a payload the size of an orange beyond the terrestrial atmosphere, Wernher von Braun recalled the conversation he had in 1955 with a group of Germans who had returned from the Soviet Union.

On the basis of their stories, von Braun told a Scripps-Howard correspondent, he drew the conclusion that the Russians had made poor use of the German specialists taken prisoner at the end of WW II. He gained the impression that they had been poorly managing their rocket program and had in essence failed to create anything that could cause anxiety.

Von Braun added that the Germans were really isolated from the real Soviet rocket program, and this isolation was so perfect that they were obviously not even aware of the existence of this program.

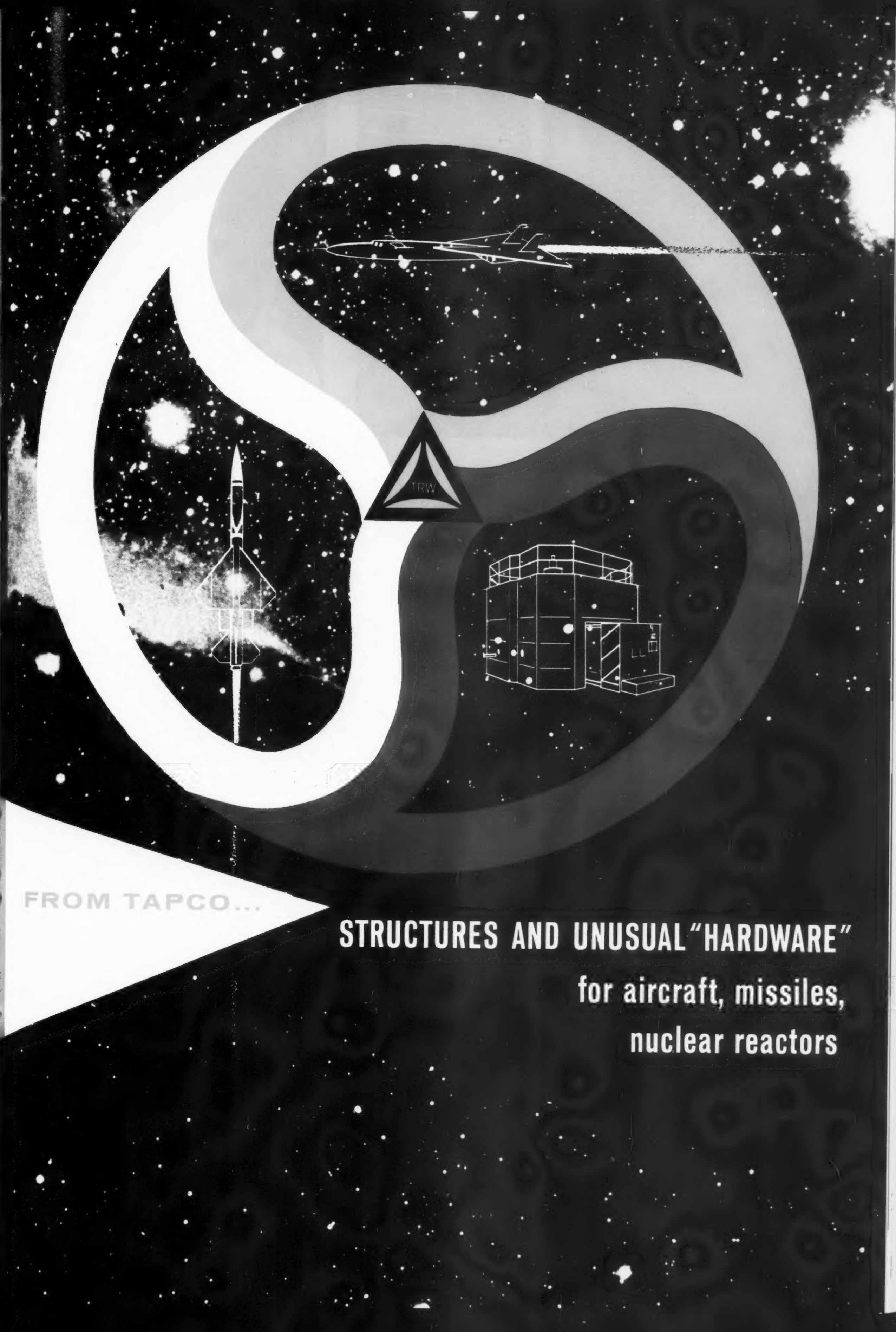
Program Brought Success

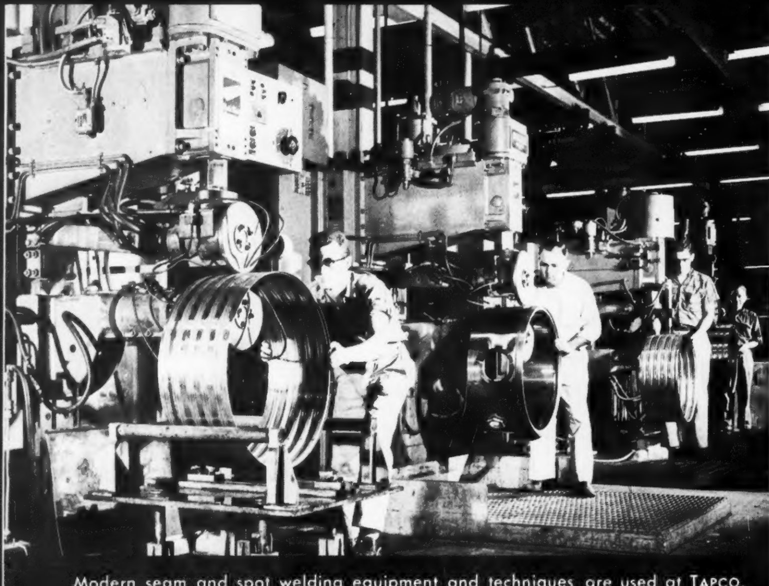
This real rocket program enabled the Soviet Union to be first to launch a satellite of the earth, first to accomplish what seemed to many people a wild fancy only 15 years ago. Now that many manmade satellites have been orbiting around the earth and sun, and now that a product of human hands has escaped from the earth's pull and reached the moon, scientists in many fields of knowledge see vast possibilities for exploring the space around the solar system and investigating the structure of the earth. This is necessary not only for the treatment of new theoretical problems; it also affords greater possibilities for their practical solution.

There can be no doubt whatever that astronautics will be advanced with constantly growing speed through the efforts of scientists of many countries, and that man, as Tsiolkovskii had foreseen already in his time, would penetrate constantly farther into the universe. However, Soviet scientists are conscious of the fact that the greatest discoveries of science can be used for the good of all mankind only in conditions of general peace. Rockets, the achievement of the human genius, must never be used for war, for the destruction of human life: That is the demand of the Soviet scientists, of all the Soviet people, of all peace-loving mankind. ♦♦

The Author's Background

Yuri A. Pobedonostsev (1902–) an active member of the Academy of Artillery Sciences, U.S.S.R.; doctor of technical sciences; associate, Kapustin Yar Test Range (1949); scientific adviser to the Ministry of Armaments (1950); member of Scientific Technical Council of Guided Missiles, U.S.S.R. (1950); professor at Moscow State Univ. Member of Interdepartmental Commission on Interplanetary Travel, Astronomical Council, Academy of Sciences (1957). Associate, Moscow Aviation Institute. Went to Moscow Higher Technical School. Stalin Prize Winner, Order of Lenin, Hero of Soviet Union. Worked on guided missile launching installation and design; statistics, supersonics, and gas dynamics; theory and design of liquid-fuel rocket engines; research through 1958.

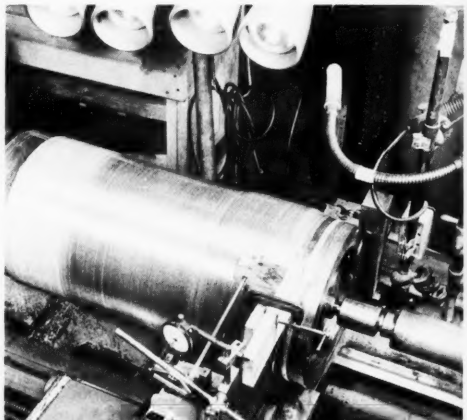

TRW
FROM TAPCO...
STRUCTURES AND UNUSUAL "HARDWARE"
for aircraft, missiles,
nuclear reactors



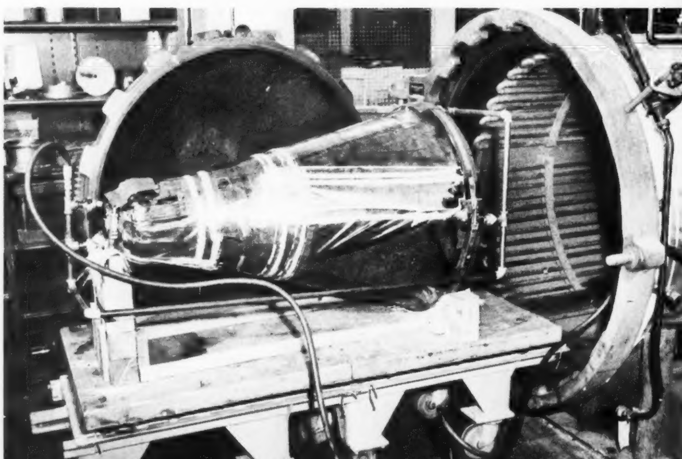
Modern seam and spot welding equipment and techniques are used at TAPCO.

TAPCO'S experience in successfully working, forming and welding unusual alloys is illustrated by this high strength case made for a solid fuel rocket engine.

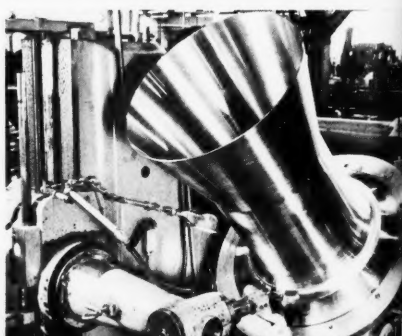
This 600-ton press at TAPCO is used to mold large exit cones for solid propellant rocket nozzles.



Winding glass fiber filaments over mandrel at TAPCO to form the shell for a reinforced plastic rocket chamber.



Special heat-resistant reinforced plastic wound altitude expansion cone being cured in autoclave. TAPCO'S autoclave is 14' long — 54" in diameter.



This 30" diameter by 45" long alloy steel missile nozzle is machined to within .002 of mean contour.

ARS news

Program Announced for ARS Solid Propellants Conference, Jan. 28–29

The announced program for the ARS Solid Propellants Conference to be held January 28–29 at Princeton Univ. will focus on defining critical problems encountered in the disciplines of combustion, ignition, mechanical properties of propellant grains, and exhaust nozzles. Informal Round Table Discussions on Friday, Jan. 29, will be reserved for those topics not covered in the formal sessions.

J. Preston Layton, chief jet propulsion engineer, James Forrestal Research Center, Princeton Univ., will chair the Conference. The University is joint sponsor with ARS, which plans to sponsor a symposium of this type on an annual basis to provide a needed open discussion forum in between annual summer meetings of the Joint Army-Navy-Air Force Solid Propellants Group (JANAF).

Registration fee for ARS members and those of the Princeton Univ. Conference will be $3.00, and $5.00 for nonmembers. There will be no registration fee for authors, co-authors, session chairmen, session vice-chairmen, and student members. Full-time students who are not ARS members will not be registered but will be admitted free when space is available.

The program follows.

Thursday, January 28

EXHAUST NOZZLE DESIGN AND THRUST CONTROL

9:30 a.m. — **Conference Room, Woodrow Wilson Hall**

Chairman: Elliott Mitchell, National Aeronautics and Space Administration, Washington, D.C.
Vice-Chairman: H. B. Jones, Princeton Univ., Princeton, N.J.

- ✦Thrust and Vector Control Requirements for Solid Propellant Rocket Engines, A. C. Keathley and B. R. Adelman, United Research Corp., Menlo Park, Calif. (1043–60)
- ✦An Experimental Study and Comparison of Contoured and Conical Nozzles, R. E. Overall, Thiokol Chemical Corp., Huntsville, Ala. (1044–60)
- ✦Graphical Methods for Selection of Nozzle Contours, O. J. Demuth and M. J. Ditore, Aerojet-General Corp., Sacramento, Calif. (1045–60)
- ✦Nozzle Design for Solid Propellant Rockets, Richard Winer and L. Morey, Allegany Ballistics Laboratory, Hercules Powder Co., Cumberland, Md. (1046–60)
- ✦The Performance of Plug-Type Rocket Exhaust Nozzles, Kurt Berman and F. W. Crimp Jr., Flight Propulsion Div., General Electric Co., Ballston Spa, N.Y. (1047–60)

COMBUSTION OF METALS (PANEL)

9:30 a.m. — **Auditorium, Frick Chemical Laboratory**

Chairman: H. M. Shuey Jr., Rohm and Haas Co., Huntsville, Ala.
Vice-Chairman: M. J. Webb, Princeton Univ., Princeton, N. J.

I. Glassman, Princeton Univ., Princeton, N.J.; D. Gordon, Stanford Research Institute, Menlo Park, Calif.; M. Farrell, Aeronutronic, A Div. of Ford Motor Co., Newport Beach, Calif.; C. P. Talley, Experiment, Inc., A Subsidiary of Texaco, Inc., Richmond, Va.; and W. A. Wood, Rohm and Haas Co., Huntsville, Ala.

LUNCHEON

12:45 p.m. — **Palmer Room, Nassau Inn**

Toastmaster: Jerry Grey, President, Princeton Section, American Rocket Society.
Speaker: C. D. Perkins, Chairman, Dept. of Aeronautical Engineering, Princeton Univ., Princeton, N. J.
Subject: "The Selection of Strategic Systems."

COMBUSTION INSTABILITY—THEORETICAL

2:30 p.m. — **Conference Room, Woodrow Wilson Hall**

Chairman: J. F. Kincaid, Advanced Research Projects Agency, Washington, D.C.
Vice-Chairman: Arnold Goldburg, Princeton Univ., Princeton, N.J.

- ✦Solid Propellant Rocket Motors as Acoustic Oscillators, F. T. McClure, R. W. Hart, and J. F. Bird, Applied Physics Laboratory, The Johns Hopkins Univ., Silver Spring, Md. (1049–60)
- ✦Gas Dynamic Instabilities in Rockets Using Solid Propellants with Metal Additives, Sin I. Cheng, Princeton Univ., Princeton, N. J. (1053–60)
- ✦Heat Transfer Stability Analysis of Solid Propellant Rocket Motors in the Study of Resonant Burning, R. Shinnar and M. Dishon, Technion, Haifa, Israel. (1054–60)

COMBUSTION AND IGNITION STUDIES

2:30 p.m. — **Auditorium, Frick Chemical Laboratory**

Chairman: Ralph Roberts, Office of Naval Research, Washington, D.C.

1960 ARS Meeting Schedule

Date	Meeting	Location	Abstract Deadline
Jan. 28–29	Solid Propellants Conference	Princeton Univ.	Past
Feb. 17–19	Ballistic Missile Defense Conference	Williamsburg, Va.	Past
March 23–25	Ground Support Equipment Conference	Detroit, Mich.	Past
April 6–8	Structural Design of Space Vehicles	Santa Barbara, Calif.	Past
May 9–12	ARS Semi-Annual Meeting and Astronautical Exposition	Los Angeles, Calif.	Jan. 18
May 23–25	National Telemetering Conference	Santa Monica, Calif.	Feb. 1
Aug. 15–20	11th International Astronautical Congress	Stockholm, Sweden	April 15
Dec. 5–8	ARS Annual Meeting and Astronautical Exposition	Washington, D.C.	Aug. 25

Send all abstracts to Meetings Manager, ARS, 500 Fifth Ave., New York 36, N.Y.

Vice-Chairman: David W. Blair, Princeton Univ., Princeton, N.J.

- ✦Ballistics of the Slotted Tube Grain and Some Practical Design Modifications, M. W. Stone, Rohm and Haas Co., Huntsville, Ala. (1055–60)
- ✦Non-Equilibrium Reactions in Solid Propellant Gas Generator Systems, F. R. Gessner Jr., Rocketdyne, a Div. of North American Aviation, Inc., Canoga Park, Calif. (1056–60)
- ✦Burning Rates of Composite Solid Propellants, W. Nashbar, Lockheed Missiles and Space Div., Palo Alto, Calif. (1057–60)
- ✦Physical and Chemical Factors Affecting Ignitibility of Composite Propellants by Convection, R. F. McAlevy III, P. L. Cowan, and M. Summerfield, Princeton Univ., Princeton, N.J. (1058–60)
- ✦Fundamental Studies of Ignition by Means of a Shock Tube, A. D. Baer, N. W. Ryan, and D. L. Salt, Univ. of Utah, Salt Lake City, Utah (1059–60)
- ✦Some Fundamental Problems of Steady-State Burning of Solid Propellants, D. W. Blair, E. K. Bastress, C. E. Hermance, K. P. Hall, and M. Summerfield, Princeton Univ., Princeton, N. J. (1060–60)

RECEPTION

6:30 p.m. — **Yankee Doodle Tap Room, Nassau Inn**

Auspices of Princeton Univ. and Thiokol Chemical Corp. (For those holding banquet tickets.)

Host: Harold W. Ritchey, vice-president, American Rocket Society and Thiokol Chemical Corp., Bristol, Pa.

BANQUET

7:00 p.m. — **Palmer Room, Nassau Inn**

Toastmaster: Ivan E. Tuhy, Chairman, ARS Solid Rockets Committee.

Speaker: Richard D. Geckler, vice-president, Aerojet-General Corp., Sacramento, Calif.

Subject: "Universities and Industry—Partners in Research."

Friday, January 29

MECHANICAL ASPECTS OF GRAIN DESIGN

9:00 a.m. — **Conference Room, Woodrow Wilson Hall**

Chairman: Joseph F. Masi, Office of Scientific Research, USAF, Washington, D.C.

Vice-Chairman: R. C. Knauer, Princeton Univ., Princeton, N.J.

- ✦Grain Design and Development Problems for Very Large Rocket Motors, A. B. Boyd, W. M. Burkes, and J. E. Medford, Rocketdyne, a Div. of North American Aviation, Inc., McGregor, Tex. (1061–60)
- ✦A Method of Strength Analysis of Solid Propellant Rocket Grains, N. N. Au, Hughes Aircraft Co., Culver City, Calif. (1062–60)
- ✦Mechanical Properties and the Design of Solid Propellant Motors, M. L. Williams, California Institute of Technology, Pasadena, Calif. (1063–60)
- ✦Stress and Strain Analysis of Cylindrical Case-Bonded Grains, J. Vandenkerckhove, Free Univ. of Brussels, and G. Lampens, Joint Powder Factories of Belgium (1064–60)

COMBUSTION INSTABILITY—EXPERIMENTAL

9:00 a.m. — **Auditorium, Frick Chemical Laboratory**

Chairman: P. L. Nichols Jr., Stanford Research Institute, Menlo Park, Calif.

Vice-Chairman: Davie T. Harrje, Princeton Univ., Princeton, N. J.

- ✦Resonant Burning of Solid Propellants—Review of Causes, Cures, and Effects, Richard H. Wall, Thiokol Chemical Corp., Redstone Arsenal, Ala. (1065–60)
- ✦Unstable Burning Phenomena in Double Base Propellants, T. Angelus, Allegany Ballistics Laboratory, Hercules Powder Co., Cumberland, Md. (1066-60)
- ✦Experimental Investigations of Unstable Combustion in Solid Propellant Rocket Motors, Ellis M. Landsbaum, G. Robillard, and F. E. Marble, Jet Propulsion Laboratory, Pasadena, Calif. (1067-60)
- ✦Analysis of Experimental Results of Combustion Instability Research, Edward W. Price, Naval Ordnance Test Station, China Lake, Calif. (1068-60)

LUNCHEON

12:30 p.m. — **Palmer Room, Nassau Inn**

Toastmaster: J. Preston, Layton, Symposium General Chairman.

Speaker: J. T. Grey, Director of Research Planning Rocket Divisions, Thiokol Chemical Corp., Bristol, Pa.

Round Table Discussions on Research Problems

COMBUSTION PROCESSES

2:00 p.m. — **Auditorium, Frick Chemical Laboratory**

Moderator: Martin Summerfield, Princeton Univ., Princeton, N.J.

Suggested Topics: Further debate on mechanisms of instability. More on combustion of metal powders, particularly in solid propellants. Ignition by radiation. Current problem areas in steady-state burning. Erosive burning phenomena. And/or other related topics.

FLUID FLOW ASPECTS OF EXHAUST NOZZLES

2:00 p.m. — **Conference Room, Woodrow Wilson Hall**

Moderator: Jerry Grey, Princeton Univ., Princeton, N. J.

Suggested Topics: Comparisons of convergent-divergent nozzles, spike nozzles, plug nozzles, and associated combustor configurations. Fluid dynamic aspects of jet deflection for steering. Thermodynamic and kinetic aspects of flow with condensed phases. More on nozzle contour optimization. And/or other related topics.

MECHANICAL PROPERTIES OF PROPELLANTS AND GRAIN DESIGN

2:00 p.m. — **Lounge, Woodrow Wilson Hall**

Moderator: E. H. Seymour, Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J.

Suggested Topics: Properties of visco-elastic media. Problems in stress prediction in various grain configurations. Comparison of bonded and unbonded grains. Special problems of large grains for space launcher applications. Ignition shock loading. Temperature effects, ambient and during exothermic polymerization. And/or other topics.

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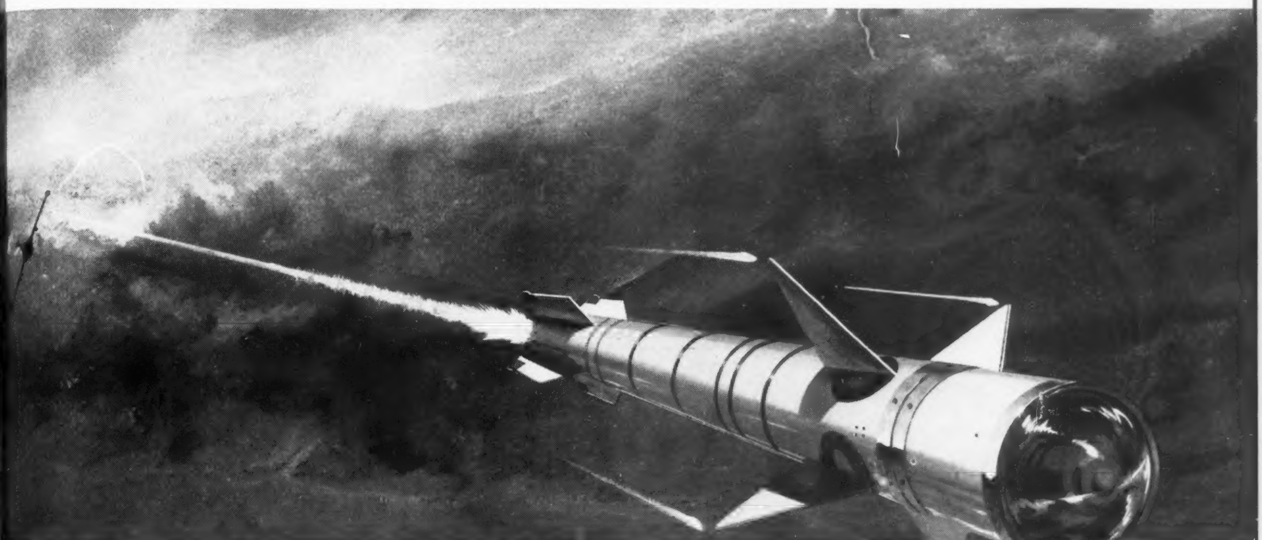

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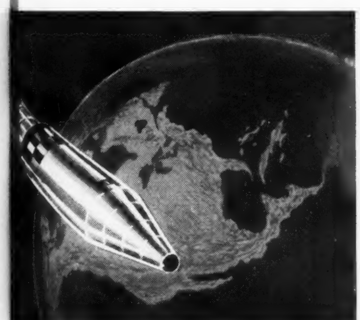

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1960

Jan. 7, 14, 21, 28	Gas Dynamics Colloquium on Electrostatic Propulsion, Shock Tube Research at the Univ. of Michigan, Structure of Strong Normal Shockwaves, and Research in Rarefied Gas Dynamics, respectively, Northwestern Univ., Evanston, Ill.
Jan. 11–16	First International Space Science Symposium, and COSPAR Plenary Session, sponsored by COSPAR, Nice, France.
Jan. 12–15	Society of Plastic Engineers' 16th Annual Technical Conference, Conrad Hilton Hotel, Chicago.
Jan. 18–21	6th Annual Meeting of American Astronautical Society, Statler-Hilton Hotel, N.Y.C.
Jan. 28–29	**ARS Solid Propellant Rocket Research Conference, Princeton Univ., Princeton, N.J.**
Feb. 1–4	ISA Instrument-Automation Conference and Exhibit, Houston Coliseum, Houston, Tex.
Feb. 3–5	IRE Winter Convention on Military Electronics, Biltmore Hotel, Los Angeles.
Feb. 4, 11, 18, 25	Gas Dynamics Colloquium on Steady-State Magnetohydrodynamic Experiments, Departures from Equilibrium in Mixing Regions, Relaxation Times in Gases, and A New Application for the Hydraulic Analogy, respectively, Northwestern Univ., Evanston, Ill.
Feb. 16–18	First National Symposium on Nondestructive Testing of Aircraft and Missile Components, sponsored by Society for Nondestructive Testing and Southwest Research Institute, Hilton Hotel, San Antonio, Tex.
Feb. 17–19	**ARS-ARPA Ballistic Missile Defense Conference, SECRET, College of William and Mary, Phi Beta Kappa Hall, Williamsburg, Va.**
Feb. 18–19	AIEE Symposium on Engineering Aspects of Magnetohydrodynamics, Univ. of Pennsylvania, Philadelphia.
Feb. 18–20	National Society of Professional Engineers Winter Meeting, Broadview Hotel, Wichita, Kan.
March 9–11	ISA Temperature Measurement Symposium, Deshler Hilton Hotel, Columbus, Ohio.
March 23–25	**ARS Ground Support Equipment Conference, Statler-Hilton Hotel, Detroit.**
April 3–8	ISA Sixth Nuclear Congress, New York, N.Y.
April 6–8	**ARS Structural Design of Space Vehicles Conference, Santa Barbara Biltmore, Santa Barbara, Calif.**
April 6–8	National Meeting of the Institute of Environmental Sciences, Biltmore Hotel, Los Angeles.
April 21–22	AIME Southwest Metals and Minerals Conference on Metals and Minerals for the Space Age, Ambassador Hotel, Los Angeles.
May 2–5	ISA Sixth National Flight-Test Symposium, San Diego, Calif.
May 3–5	IRE-AIEE Western Joint Computer Conference, San Francisco.
May 9–11	ISA Third National Power Instrumentation Symposium, San Francisco.
May 9–12	**ARS Semi-Annual Meeting and Astronautical Exposition, Ambassador Hotel, Los Angeles.**
May 9–12	ISA Instrument-Automation Conference and Exhibit, San Francisco.
May 23–25	**ISA, ARS, IAS, AIEE National Telemetering Conference, Miramar Hotel, Santa Monica, Calif.**
June 2–3	4th Annual Summer Conference on Vacuum Metallurgy, NYU College of Engineering, University Heights, Bronx, N.Y.
June 8–11	National Society of Professional Engineers Annual Meeting, Statler Hotel, Boston.
June 15–17	1960 Heat Transfer and Fluid Mechanics Institute, Stanford Univ., Stanford, Calif.
July 21–27	3rd International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers and International Federation for Medical Electronics, Olympia, London.
Aug. 15–20	**11th International Astronautical Congress, Stockholm, Sweden.**
Aug. 31–Sept. 7	10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy.
Oct. 20–21	Hypervelocity Projection Techniques Conference, Univ. of Denver, Colorado.
Dec. 5–8	**ARS Annual Meeting and Astronautical Exposition, Shoreham Hotel, Washington, D.C.**

Intl. Astronautical Congress Offers Broad Program

Topics to be covered at the 11th International Astronautical Congress to be held August 15–20 at The Royal Institute of Technology in Stockholm, Sweden, have been released by Svenska Interplanetariska Sallskapet, the Swedish Interplanetary Society.

The announced list of sessions for which papers will be accepted includes the following fields: Basic Sciences; Planetary Atmosphere Environments; Interplanetary Space; Space Medicine and Biology; Trajectories; Navigation, Guidance, and Control; Space Communication; Propulsion; Vehicles; Space Probes, Satellites, High-Altitude Rockets; and Economic Factors. In addition to the above fields, SIS is considering a special Space Medicine Symposium and a separate Space Law Colloquium. Papers not falling within these categories will be accepted for a special session.

In all, a total of 65 papers will be accepted for presentation in parallel sessions, aside from papers for the possible Space Medicine and Space Law meetings.

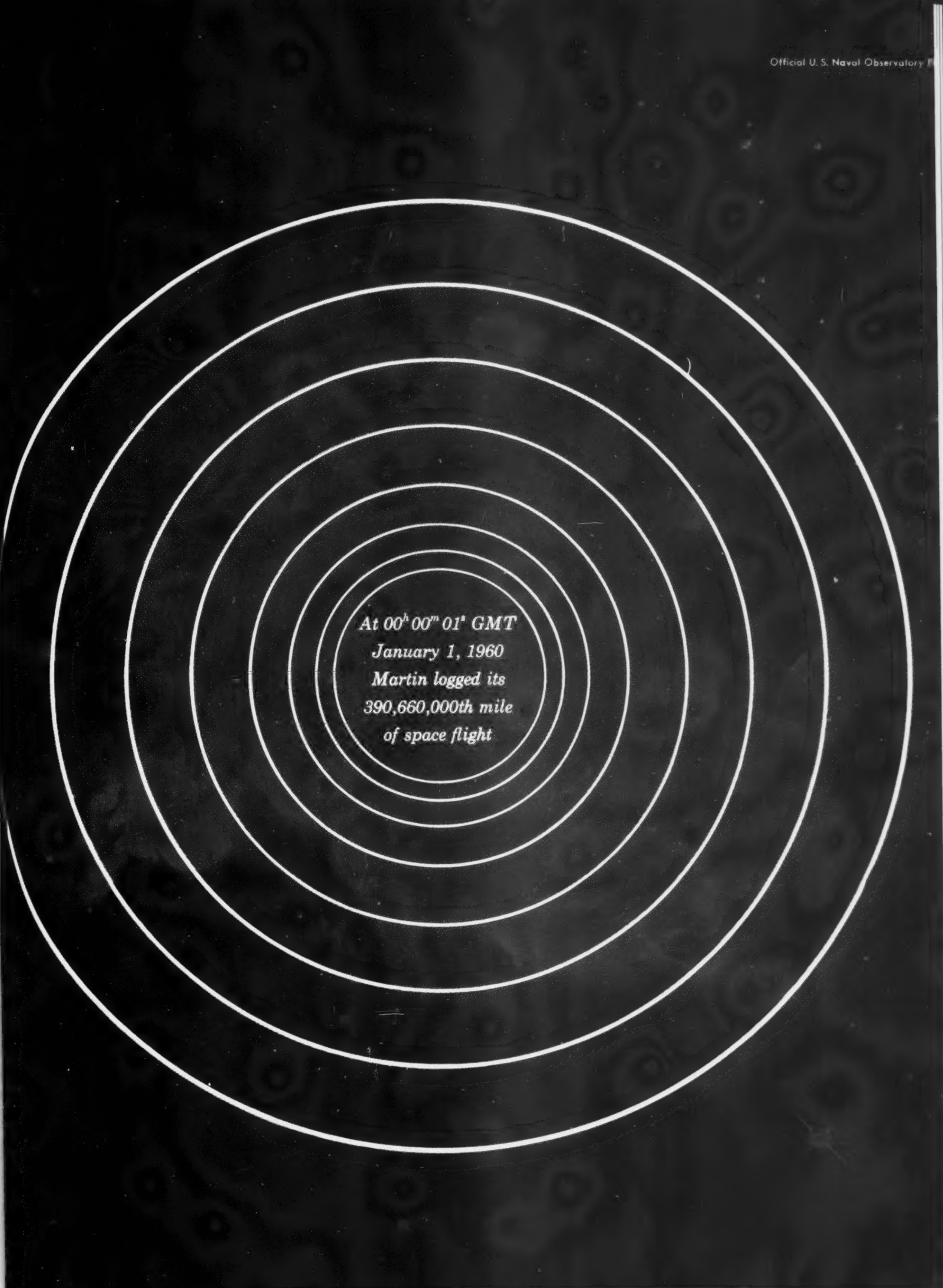
Only original contributions not published in any form prior to the Congress and which meet an internationally accepted standard will be considered for presentation. Papers may be written and given in English, French, German, or Russian, although, if convenient, English is recommended.

ARS members interested in submitting manuscripts for presentation at the Congress should first send an abstract in English for preliminary screening to ARS Program Committee, 500 Fifth Avenue, New York 36, N.Y. These should reach here by no later than March 30. Final papers must be in the hands of the appropriate ARS technical committee by May 1. These papers must be accompanied by an authorized summary in English of 500 to 1000 words.

New Corporate Member

Bulova Research & Development Laboratories, Inc., has become a corporate member of the American Rocket Society. The company is prime contractor for the Pershing missile and manufactures timing devices for the Corvus, Juno, Saturn, Explorer VII, and component parts for a large number of missiles.

Representing the company in ARS activities are: O. B. Brockmeyer, vice-president, engineering sales; Charles Crescas, chief electromechanical engineer; Norman Alpert, chief elec-



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MARTIN

tronics engineer; Stewart Fenton, assistant chief engineer; and George Geyer Sr., project engineer.

General Chairman

Bernard J. Meldrum, special assistant to the general manager of Chrysler Corp.'s Missile Div., has been named General Chairman of the ARS Ground Support Equipment Conference, to be held in Detroit, March 23–25.

B. J. Meldrum

Papers Sought

The ARS Nuclear Propulsion Committee is seeking papers for the unclassified session on Advanced Propulsion Reactor Concepts at the ARS Semi-Annual Meeting in Los Angeles in May. Abstracts of proposed papers should be sent to C. J. Wang, Space Technology Labs, P.O. Box 95001, Los Angeles 45, Calif., before March 1.

SECTIONS

Chicago: The October meeting, held at Motorola Inc., featured an illustrated lecture on precision instrumentation by Dr. Roth, director of the Roth Laboratory for Physical Research in Hartford, Conn. Ross A. Simpson was Motorola's host for the evening and first presented a brief description of Motorola's work in the missile and space field.

Dr. Roth discussed various new devices developed in the Roth Laboratories, including sensing elements and associated transistorized and electronic components to measure pressure, temperature, vibration, and fluid flow. Of particular interest was a flowmeter which determines flow rates accurate to 1 part in 2000 and can be used over a broad range of conditions, varying from flow rates in liquid rocket engines to measuring blood flow in a person's extremities.

—R. C. Warder Jr.

Connecticut Valley: Some 75 members and guests attended a dinner meeting in October at the Hamilton Standard Div. of United Aircraft in Windsor Locks, Conn. The speaker for the evening was **Secor D. Browne,** president of Browne and Shaw, Inc., and professor of modern languages and vice-director of libraries at MIT. In the latter capacity, he spent the month of October 1958 in the U.S.S.R. arranging the exchange of scientific literature between MIT and the Russian Academy of Sciences and visiting libraries, universities, and technical institutions. His topic for the evening, "The Soviet Engineer," reflected this visit. He discussed the education, technical aptitude, working conditions, and advancement opportunities of Soviet engineers and compared the social standing of engineers with other professionals and nonprofessionals in the U.S.S.R. He noted that an extremely high proportion of Soviet engineering personnel are women.

—Frank Gabron

Holloman: At the November dinner meeting, Knox Millsaps, chief scientist of the Air Force Missile Development Center, turned over the duties and responsibilities of the Section's presidency to Harold J. von Beckh, who is scientific adviser to the Aeromedical Field Laboratory at AFMDC. Other new section officers elected were: Lt. Col. Bernard W. Marschner, vice-president; Harry H. Clayton, secretary; and Kenneth M. Haggard, treasurer.

Houston: This new Section held its October dinner meeting at the Houston Engineer's Club. The guest of honor and main speaker for the evening was **Col. John P. Stapp,** immediate past-president of ARS.

After dinner, the executive secretary, Jamie B. Dancer, gave a short talk on the feminine aspect of space; and the vice-president, Dennis Ashton, briefly discussed the educational aims of ARS. This was followed by the introduction of Col. Stapp by Tom Filban, a local board director.

Col. Stapp then presented Larry Megow, Section president, with the charter. After the presentation ceremonies, Col. Stapp spoke on man's tolerance to space environment.

Following his talk, the Houston Chamber of Commerce presented Col. Stapp with a certificate making him an honorary Houstonian.

—Ronald Pinkenburg

New England: The following new Section officers were elected at a dinner meeting last fall: Peter H. Rose, president; A. John Gale, vice-president; Joseph E. Lavelle, treasurer; and Warren A. Tucker, secretary. Guest speaker for the evening was **Col. Ernest A. Pinson,** USAF, who discussed "Geophysics in the Space Age." Col. Pinson is director of the AFCRC Geophysics Research Directorate.

St. Louis: William E. Felling, of the Research Dept. of McDonnell Aircraft, addressed the October meeting of the Section on the subject, "Project Eclipse." This was the McDonnell-AFCRC joint effort during the total solar eclipse of October 2, 1959, in the Canary Islands. During this eclipse, a McDonnell F101-B Voodoo aircraft flew in the shadow of the eclipse for 6 min and 51 sec measuring the polarization of the light of the solar corona, in an effort to substantiate a theory of the existence of a synchroton radiation belt around the sun. Such a radiation belt would be analogous to the Van Allen radiation belt around the earth.

Dr. Felling stated that the altitude and speed of the plane enabled the taking of photographs and measurements that were much clearer and over a much longer period of time than were possible by other observers. As yet, the data has not been evaluated to determine whether a synchroton belt around the sun was detected. Slides of some of the photos taken during the eclipse were exhibited to the audience.

—Albert E. Cohen

Southern California: An overflow crowd attended the November meeting and heard **E. R. Schuberth,** manager of missile and spacecraft engineering for the California Div. of Lockheed Aircraft, describe and discuss the Lockheed-Hughes proposal for a space ferry (see page 66). The speaker and audience shared a mutual

There Are Risks

A. L. Antonio, at right, vice-president of Aerojet's Chemical Div., shown above with C. M. Beighley, president of the Sacramento Section, gave some insights into capital risks in defense industries at a recent Section meeting.

Hi-Speed Microwave Complex Links NAA Plants

The microwave equipment above at North American Aviation's Los Angeles Div. receives scientific and business data at the rate of 3000 words per sec, or 180,000 words per min, from another computer, about 40 miles away, at the Rocketdyne plant in Canoga Park, Calif. Signals beamed from Rocketdyne are picked up by a microwave dish on Oat Mt., nine miles away, and are transmitted to the LA Div. Other NAA divisions are slated to be included in the system shortly. Engineers from Pacific T&T and IBM's Advanced Systems Development Div. developed the system for NAA, which says this is the first time information has been transmitted from one computer to another without using direct wire.

enthusiasm in this very successful meeting.

—Eric Burgess

Wichita: Thirty-nine members attended the regular monthly meeting in November, held at the Wallace Plant Cafeteria of the Cessna Aircraft Co., and heard **Bruce E. Peterman,** chief of propulsion for Cessna's Military Div., speak on the T-37 engine induction system photo survey (tuft study). A film on this subject was also shown.

Also, at this meeting, the Section elected new officers, who are as follows: E. H. Roberts, president; T. R. Taylor, vice-president; R. J. Nyenhuis, secretary; and D. C. Roth, treasurer.

—Dean E. Burleigh

STUDENT CHAPTERS

Boston Univ.: The first meeting of the new academic year was opened by our president, Walter Kimball, who introduced the officers and our faculty adviser, Professor Chin, to over 53 members and interested undergraduates. On the agenda was a proposal for building a steam rocket. The building of the rocket would be under the supervision of one of the faculty members, who would volunteer his services.

The second half of the meeting was carried on by our activities chairman, Bill Hart, who had received films from Bell Aircraft. The showing of these concluded the meeting.

—Jason Selden

Georgia Tech: Despite inclement weather, 25 members of the Chapter met in November to hear **Samuel Arline** of Pratt & Whitney's Florida division discuss liquid hydrogen-liquid oxygen rockets, and in particular the Centaur project. This was both an interesting and educational presentation.

—Vernon Porter

Univ. of Virginia: The Chapter recently elected a new slate of officers, who are as follows: Loran R. Smith, president; Stanford W. Horstman, vice-president; Otis B. Bacon, secretary; and Roger M. Karpf, treasurer. The Chapter looks forward to a busy and exciting new year.

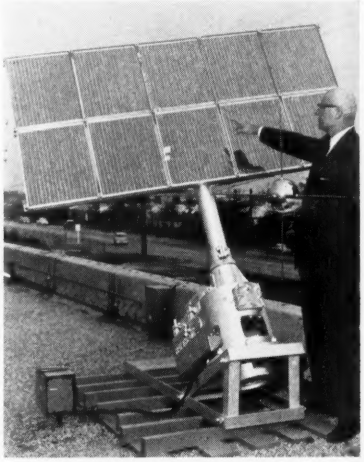
—H. Duane Evans

Univ. of Washington: The Chapter held its first meeting of the school year in October. Our speaker for the evening was **Thrift Hanks,** director of health and safety at Boeing Airplane, who spoke on space medicine for orbital and short-range space travel. His talk included information on the problems of acceleration, or lack of it, noise and heat in relation to comfort, and functional and survival parameters. He also discussed closed ecological systems, escape methods, and the difficulties associated with equipment reliability. To supplement his talk, Dr. Hanks showed a film from WADC on weightlessness.

—Patricia L. Blake

Hoffman Electronics Opens New Semiconductor Center

Hoffman Electronics Corp. recently formally dedicated its new $2-million Semiconductor Center, a 109,000-sq-ft plant in El Monte, Calif., designed to mass produce solar cells and to be used as an advanced research and production facility for solid-state devices. According to H. Leslie Hoffman, the Semiconductor Center "was designed to meet the nation's growing requirements for electrical power generators in space vehicles."



Hoffman Electronics president, H. Leslie Hoffman, compares Big Bertha with tiny converters used in Vanguard I. Bertha's 7800 solar cells will be used to power the Semiconductor Center's permanent solar energy applications exhibit.

Grass Roots

John Rosen, at right, publicity chairman for the Boston Univ. Chapter, suggests to Edward Chin, one of 50 some members and interested undergraduates who attended the Chapter's first fall meeting, that he take a look at *Astronautics*.

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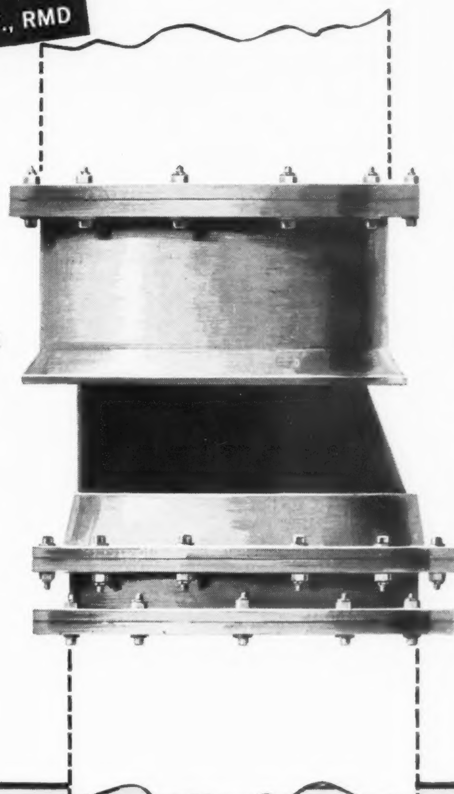

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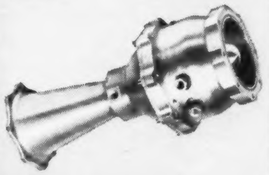
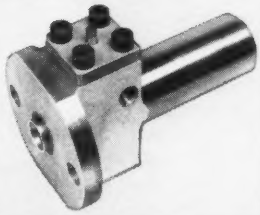
For cryogenic, corrosive or conventional fluids. No larger than line section it replaces. No dynamic seals. Working fluid actuated. Cavitating or non-cavitating.



Explosive actuated on-off valve

For all liquids and gasses. Reusable without disassembly or removal from line.



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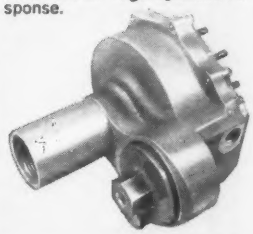

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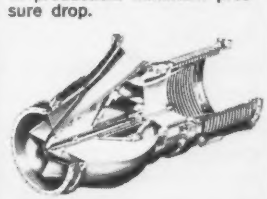


Components Department **REACTION MOTORS DIVISION**

Thiokol CHEMICAL CORPORATION

Ford Road, Denville, New Jersey

CORPORATE MEMBERS

Aerojet-General has announced integration of its architectural-engineering unit with its electronic design groups into a new division to be known as AETRON, which will operate from its own plant in Covina, Calif. The company's Atlantic Div. recently dedicated a new $150,000 lab and office building in Frederick, Md.; and a new customer-relations office was set up in Detroit to service Aerojet business in north central U.S. . . .**Boeing Airplane Co.** is negotiating acquisition of Vertol Aircraft Corp. on the basis of two shares of Boeing for three shares of Vertol. . .**Clevite Transistor Products,** Div. of Clevite Corp., has drawn up plans for its new multimillion dollar, 165,000-sq-ft manufacturing, laboratory, and office facility. . .**Douglas Aircraft** has formed an Advanced Research Organization, primarily for advanced research. Also established were two new corporate functions known as Defense Programs and Commercial Programs.

GE has created an Information Systems Section within its Defense Systems Dept.; it will be headquartered at Bethesda, Md. . . .If stockholders of both companies approve, **General Dynamics Corp.** will absorb Material Service Corp. of Chicago. . . A new Defense Systems Div. has been activated at **General Motors**. . . **Hercules Powder Co.** has announced plans for a multimillion dollar expansion of its West Coast manufacturing facilities for production of methanol, formaldehyde, urea-formaldehyde concentrates, and slow nitrogen release urea-form for fertilizer applications. . . **Hydro-Aire** has purchased the business of Lyndon Aircraft, Newark, N.J., manufacturer of such proprietary items as magnetic flutter dampeners and actuators for aircraft and missiles. . . **Leach Corp.** has purchased the Electronics Div. of Pendar, Inc., Van Nuys, Calif. . . .**Linde Co.**'s new liquid-hydrogen facility at Tonawanda, N.Y., has gone on stream. It can produce more than 25,000 liters/month with less than 2 ppm impurities. . . **Martin Co.**'s recently formed Activation Div., responsible for activating the Titan weapon system in the field, is to be housed at Denver, Colo. . . . **McDonnell Aircraft**'s new $5 million polysonic airflow laboratory, with wind tunnel for studying flight characteristics at speeds of more than 4000 mph, has been put into operation. . . **Minneapolis-Honeywell Regulator Co. Semiconductor Div.** has announced plans for construction of a $1-million R&D center at Riviera Beach, Fla.

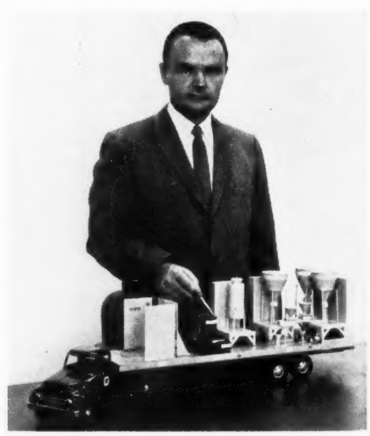
North American Aviation has established Nucleonics, a new engineering subdivision embracing nuclear and electrical propulsion and nonpropulsive power generating systems at Canoga. A European office for all of Autonetics' business in the European market has been established at Geneva. . .**Varian Associates** has formed a new subsidiary, Varian A.G., at Zug, Switzerland. . .**Wyandotte Chemicals Corp.** has established a new Corporate Development and Planning Div.

Solid-Propellant Processing Takes to the Road

Rocketdyne is developing a "Quickmix" solid-propellant manufacturing technique that will permit on-site loading of rocket motors. Recently, it loaded a pilot plant for Quickmix operations on a 30-ft truck trailer and hauled it to its Solid Propulsion Operations plant at McGregor, Tex. Shown here in model form, this plant has a minimum capacity of 500 lb of propellant per hour, and has been used to produce several propellant formulations.

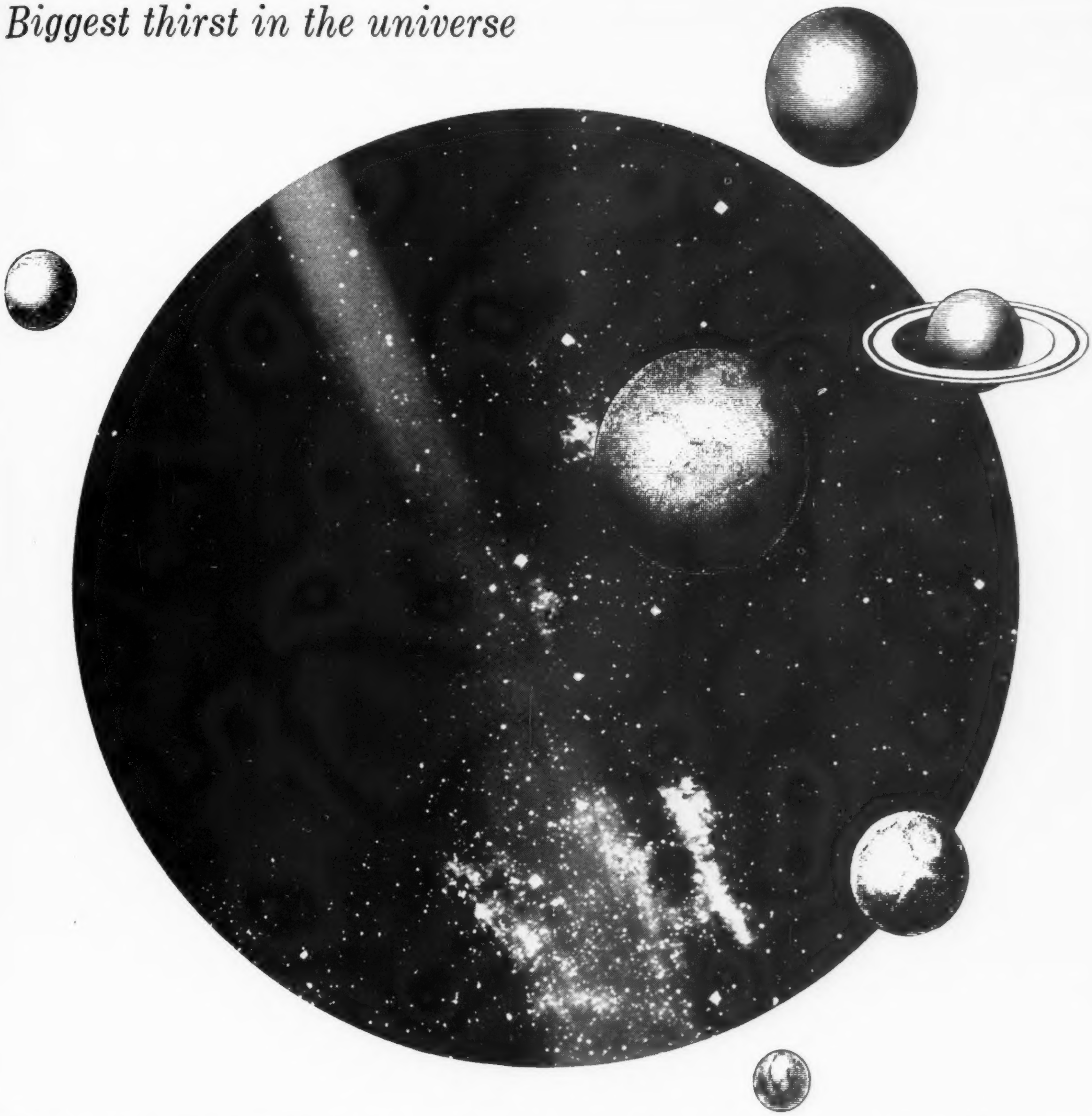
In the Quickmix process, dry and liquid propellant ingredients are prepared separately, dispersed or emulsified separately in liquid carriers, and then blended in a matter of seconds in a small mixer. This prevents heat buildup and requires only low power in the mixing operation.

Rocketdyne believes the Quickmix technique should be able to produce most known solid propellants and to be changeable quickly from one formulation to another.



John Tormey, chief engineer of Rocketdyne's Solid Propulsion Operations at McGregor, Tex., points out the mixer on a model of a transportable "Quickmix" pilot plant having a minimum capacity of 500 lb of propellant per hour.

Biggest thirst in the universe



Each 6,000,000 pound thrust rocket ship now being planned for manned interplanetary exploration will gulp as much propellant as the entire capacity of a 170 passenger DC-8 Jetliner in less than 4 seconds! It will consume 1,140 tons in the rocket's approximately 2 minutes of burning time. Required to carry this vast quantity of propellant will be tanks tall as 8 story buildings, strong enough to withstand tremendous G forces, yet of minimum weight. Douglas is especially qualified to build giant-sized space ships of this type because of familiarity with every structural and environmental problem involved. This has been gained through 18 years of experience in producing missile and space systems. We are seeking qualified engineers and scientists to aid us in these and other projects. Some of our immediate needs are listed on the facing page.

Dr. Henry Ponsford, Chief, Structures Section, discusses valve and fuel flow requirements for space vehicles with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

Space Ferry Proposed by Hughes-Lockheed

Aiming at major space operations, Lockheed and Hughes have revealed joint plans for a rocket ferry to shuttle men and supplies between earth and space for the construction and maintenance of satellite stations. The rocket-boosted space vehicle could also be used, according to the companies, to track and inspect unidentified objects in space, serve as a "space sweeper" to remove derelicts from spacelanes, act as a space-systems testing and training facility, and perform short-term scientific missions.

The ferry, along the lines of the model shown here, would pack a 14,000-lb payload in a typical rendezvous mission involving 2 to 10 orbits over a period of 3 to 12 hr. Arriving near its target, the ferry would be changed from a symmetrical-arrowhead to a flying-wing configuration by unfolding a 1000-sq-ft wing and exposing the manned capsule payload. An astronaut would then pilot the craft, using optical and radar homing devices to find the direction and distance to the station, 12 reaction jets (spaced along the wing) and internally housed electrically driven inertia wheels to control the vehicle in an approach to the station, and a 7500-lb-thrust throttleable rocket motor for maneuvering.

The difficult re-entry phase of ferry operation would be made through a retrograde thrust impulse that would put the vehicle into a glide pattern, with entry angle between 1 and 2 deg from the local horizontal and angle of attack about 45 deg (L/D of 1). The vehicle, radiation cooled, would experience maximum re-entry temperature of about 2500 F. Landing would be conventional at about 100 mph.

Vehicle structure would be based on open trusswork of thin-gauge metal, e.g., nickel, cobalt, and molybdenum alloys. Aerodynamic surfaces would involve thin sheet corrugated for stiffening. A novel control system would derive re-entry control data from structural temperatures.

Roy E. Wendahl (left) and Burt C. Monesmith, vice-presidents of Hughes and Lockheed, respectively, hold model of space ferry proposed jointly by their companies.

The astronaut would play a major piloting role in the space ferry, both in station approach and in re-entry.

The independent design studies conducted thus far by the companies indicate that their space ferry system could be developed and put into service by 1965. A design proposal has already been presented to appropriate government agencies. ♦♦

Interview with Soviets

(CONTINUED FROM PAGE 35)

On the future: Both the U.S. and U.S.S.R. have had great successes in space exploration, and the future holds great promise for both nations.

On the Soviet man-in-space program: While the ultimate goal of the over-all Soviet space program is to put man into space, the Russians say they have no man-in-space program in the same sense as our Project Mercury; that is, they are not at this time preparing Soviet astronauts for a specific mission or vehicle. Manned spaceflight is not a thing for the immediate future, and there is no target date for a Russian man in space. Man will be included in the Soviet program only (1) when he can be sent into space with complete safety; (2) when it appears certain he can be recovered unharmed; and (3) when he can serve some useful scientific purpose in space. They stress the importance of recovering the man alive, noting that such experiments make no sense if the man is brought back dead.

On Soviet biological experiments: The Laika experiment was the only one in which an animal was sent aloft in a satellite to date. However, biological experiments are going forward, and rocket firings of animals (mostly dogs), which have been going on for more than 10 years, are being continued. The Russians seem very sure of the techniques used in such experiments. Animals making these flights, which are of relatively short duration, have suffered no radiation damage. Russia does not have an Academy of Space Medicine. Instead, space medicine research is carried out by the Academy of Medical Sciences and the Academy of Sciences.

On space radiation: In addition to the danger to man from the Van Allen radiation belts, Lunik shots indicate great danger to man from protons from the sun, starting beyond the Van Allen layers.

On Lunik guidance: A mixed radio-inertial guidance system was used in all three Lunik shots, with guidance provided only up to the point of injection into orbit, the vehicles coasting from that point to the moon without correction. (A top American scientist, on hearing this, commented that the guidance system was remarkably accurate in the Lunik II and III shots, and that Russian guidance now appears to match propulsion. Accuracy of the system is such, he added, as to make it evident that an ICBM with a system of this type could hit any target it was aimed at.)

On tracking: Radio and radar are being used for the major Soviet tracking effort, with Moonwatch activity now at a minimum.

On Soviet launching failures: The Russians have experienced some failures in attempting to launch space vehicles. Premier Nikita Krushchev mentioned one in connection with Lunik II.

On a Soviet equatorial launching site: The Russians have no plans at present for an equatorial launching site.

On fantasy and reality: Throughout the meeting, the Soviet scientists drew a sharp line of demarcation between "fantasy" and "reality." At the Astronautical Exposition, for example, they seemed amused by some of the more futuristic exhibits, but paid close attention to hardware. Also, when presented with a series of *Astronautics* cover plaques, which they had requested, they went through them very carefully, asking which ones were "fantastic" and which were real.

On newspaper rumors about future plans: Newspaper men are the same the world over. Don't believe all you read.

On the amateur rocketry problem: There is no such problem in Russia, where rockets are regarded as being for men, and not for boys. Rockets are not toys, but scientific tools, to be used for scientific purposes. It takes years of training before someone is permitted to have anything to do with rockets in Russia. ♦♦

ASTRONAUTICS Data Sheet — *Propellants*

Compiled by Stanley Sarner

Flight Propulsion Laboratory Dept.
General Electric Co., Cincinnati 15, Ohio

HYDRAZINE (N_2H_4)

Hydrazine is a clear, colorless hygroscopic liquid with an odor similar to that of ammonia. It decomposes at a rate of less than 1.5 to 2 per cent per hour at 200 C and 600 psia, but it may detonate after a rapid pressure rise at about 255 C. Because of this possibility, regenerative cooling with hydrazine is difficult even though its heat-transfer properties are excellent. In addition, its high freezing point is detrimental. However, if these two problems are overcome, hydrazine's high performance and high density make it an excellent fuel. Data on hydrazine (molecular weight of 32.048) is given in the tables on this page. The performance with ClF_3 is based on later figures than given in the November 1959 issue of *Astronautics*.

Hazards

Hydrazine is insensitive to shock, but it is quite flammable and forms explosive mixtures with air in all concentrations above 4.7 per cent hydrazine by volume. Even when nitrogen is the diluent, hydrazine forms inflammable mixtures above 38 per cent. Open flames, sparks, and oxidizing materials should be avoided.

The maximum tolerable concentration in air for regular exposure has not been definitely established, but preliminary tests have suggested values in the range of 0.5 to 1 ppm. The eyes, nose, throat, and skin can be harmfully affected by hydrazine. Gas masks with ammonia canisters should be used in the presence of vapors, as should rubber gloves and goggles. Liquid hydrazine is corrosive to body tissue and must be promptly removed by washing with large quantities of water and treated for alkali burn. Egg whites followed by a mild emetic should be administered in the event of accidental ingestion.

Materials for Handling

Recommended materials for handling hydrazine include Types 303, 304, 321, and 347 stainless steels, 3S, 996, 52S, and 54S aluminum, Teflon, and high-density polyethylene. Flexible hose of Teflon covered with stainless-steel braiding is most satisfactory. Gasketing should be Teflon, polyethylene, or Type 304 spiral-wound stainless steel. Solid Teflon cylinders, chevron V-rings, or braided Teflon are suitable for use as valve stems. Braided Teflon or braided asbestos impregnated with Teflon as well as mechanical seals for centrifugal pumps are recommended for rotating shafts.

Materials which should not be used in contact with hydrazine include all stainless steels containing more than 0.5 per cent molybdenum, Hastelloys, 40E aluminum, monel, zinc, magnesium, lead, iron, and copper or its alloys. Particular care should be taken to exclude copper salts or finely divided rust, since these will catalyze the decomposition of hydrazine to the point of detonation.

Cost and Availability

Anhydrous hydrazine is available in 240-lb (net) drums at $3.25/lb, in 440-lb (net) drums at $3.15/lb (1–4 drums) and $2.95/lb (5 or more drums), and in car load and tank car quantities. In smaller quantities, it can be had for $4.45/lb in 5-lb bottles and $8.50/lb in 1-lb bottles.

Table 1 Physical Properties of N_2H_4

Boiling Point	113.5 C	236.3 F
Freezing Point	1.5 C	34.7 F
Critical Temperature	380 C	716 F
Critical Pressure	145 atm	2231 psia
Density at 25 C	1.0 g/cm³	62.4 lb/ft³
Viscosity at 25 C	0.90 cps	...
Thermal Conductivity at 25C	...	0.29 Btu/hr ft F
Vapor Pressure at		
30.7 C	0.026 atm	0.39 psia
62.5 C	0.132 atm	1.93 psia
Flash and Fire Point (Cleveland Open Cup)	52.2 C	126 F

Table 2 Chemical Properties of N_2H_4

Heat of Formation (liquid) at 25 C	+12.05 kcal/mole
Heat of Vaporization at Boiling Point	9.600 kcal/mole
Heat of Fusion at Freezing Point	3.025 kcal/mole
Heat Capacity at 25 C	23.72 cal/mole C
Maximum Allowable Concentration in Air	0.5–1.0 ppm

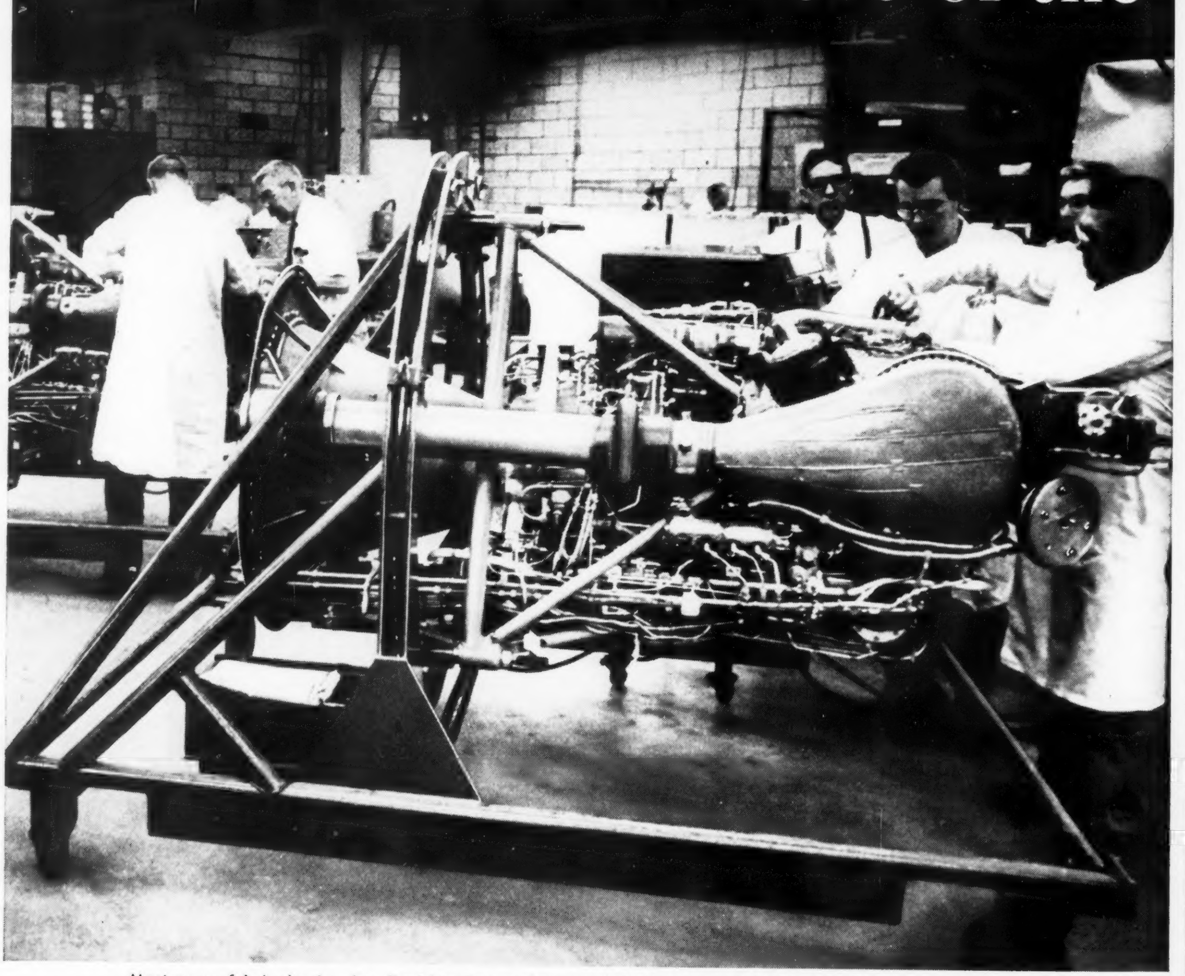
Table 3 Theoretical Performance of N_2H_4*

Oxidizer	Specific Impulse (sec) Frozen Flow	Specific Impulse (sec) Equilibrium Flow	Chamber Temperature** Deg K
O_2	301	313	3144
F_2	334	363	4419
ClF_3	279	293	3896
N_2O_4	283	292	2994
95% H_2O_2	277	282	2597
RFNA	277	283	2828

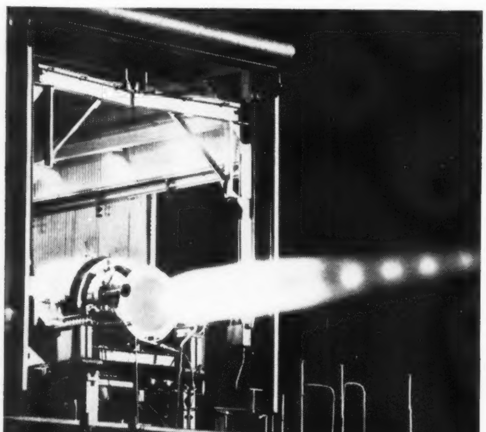
* P_c = 1000 psia; P_e = 1 atm; optimum O/F ratio.
** Corresponds to equilibrium flow impulse.

CUT ALONG THIS LINE

Research-Core of the



Most powerful single chamber liquid rocket engine ever built for manned flight—XLR-99—will drive the X-15



Test firing the XLR-99 . . . a major step in research supporting special design and production techniques.

North American Aviation Test Pilot, Scott Crossfield stands by the X-15—America's first manned space craft.

In print

Target for Tomorrow by I. M. Levitt, Fleet Publishing Corp., New York, 1959, 328 pp., illustrated. $4.95.

In this new book, I. M. Levitt, director of the Fels Planetarium in Philadelphia, astronomer, teacher and, for the past eight years, author of a syndicated column on astronautics, has provided an interesting and informative book for the educated layman on future space travel. Well organized, grounded in fact and entertainingly written, the book is made up of a number of Dr. Levitt's columns, expanded and brought up to date, as well as a vast amount of new material. The expanded columns make up the first half of the book, and deal with past and present astronautical projects and activities, while the second half, containing the new material, is concerned primarily with what is to come.

The first three chapters cover the basic facts of astronautics—the earth and its physical characteristics, its atmosphere, etc.; the laws of planetary motion and elements of orbits; and escape from earth and how it is achieved. From here, Dr. Levitt passes naturally to advanced propulsion systems, satellites and their uses, space stations, and observatories in space. Next comes a section devoted to man in space—the hazards he faces, the spacesuit which will protect him from some of these hazards, and man and the moon. The last five chapters are devoted to the future, covering the establishment of a closed ecological system on the moon, navigation to the planets, time dilation and, perhaps most interesting of all, the building and use of a space Noah's Ark to travel to the stars—an idea which has intrigued science-fiction writers for years.

Two appendixes offer an astronomer's conjecture as to what the other side of the moon may look like and a rather superficial examination of the education and training of space engineers. The latter contains the interesting suggestion that it might be possible for a large number of graduate students working at a university to use a collection of low-cost off-the-shelf research rockets to build a vehicle which can climb to 10,000 miles at a cost of about $50,000. If this is true, one can only wonder why universities, as well as the government, haven't already constructed vehicles of this type.

All in all, Dr. Levitt has turned in a workmanlike, if unspectacular, addition to the literature of astronautics. A 16-page portfolio of illustrations provides some first-rate astronomical photographs, as well as some interesting speculative drawings of future space projects.

—I.H.

BOOK NOTES

Astronomy by Theodore G. Mehlin (392 pp., John Wiley and Sons, New York, N. Y., $7.95) is a clearly written, well-illustrated and well-bound introductory text in astronomy. The author, Field Memorial Professor of Astronomy at Williams College, amplifies a nominal description of the known universe and its representative bodies by emphasizing the means employed for astronomical observation and analysis. He brings out the historical continuity of astronomy, and gives a judicious review of conflicting cosmological theories. A list of review questions is appended to each chapter. This book can be recommended to the student with a background in high-school chemistry and physics.

Medical Science and Space Travel by William A. Kinney (150 pp., Franklin Watts, Inc., 575 Lexington Ave., New York 22, N.Y., $3.95), offers some light reading on AF studies of human factors in spaceflight—acceleration, feeding, sensory deprivation, heat resistance, pyschological and physical aptitude, etc.—along with many interesting photographs of test subjects and equipment and general background on the expected course of manned spaceflight.

The Air Force Blue Book—USAF Yearbook, Vol. I (384 pp., softbound, Military Publishing Institute, New York, N.Y., 1959, $1), the first of a series of yearbooks on the Armed Forces, consists of general-interest and background articles on AF activities and over 100 pages of facts on the Air Force. Prepared with AF cooperation, this volume is a compact source of AF information, and will be sold in base exchanges around the world. A hardcover edition is available for $4.95.

Aviation Facts and Figures, 1959 Edition (147 pp., paperbound, American Aviation Publications, 1001 Vermont Ave. N.W., Washington 5, D.C.,

$2), is a handy little survey of the aviation and missile industry, consisting chiefly of summary tables of production figures, monies expended, agencies, projects, and the like. There is a fairly good section on R&D funding, and a short section on the national space program.

Basics of Missile Guidance and Space Techniques, Vols. 1 and 2, by Marvin Hobbs (John F. Rider Publishers, 116 W. 14 St., New York 11, N.Y.), surveys the important basic systems for guidance, navigation, and telemetry, and the use of these systems in space technology. Vol. 1 covers systems and equipment, and Vol. 2 space applications. The discussion, amplified by a great many simple illustrations and line drawings of techniques and equipment, is suitable for advanced high-school students. The two volumes are available together in cloth binding for $9, while separate volumes (about 145 pages each), in paperback form, are $3.90 each.

Astronautical pioneer Hermann Oberth, who devoted a considerable portion of his previous book, "Man into Space," to a description of a moon car of his own design, now offers a full-scale analysis of the vehicle in **The Moon Car** (Harper, 98 pp., $2.95). Translated by Willy Ley, the book (actually a long technical paper) discusses in detail its design, power, and steering requirements, operation on the moon, and dozens of other questions about its construction and use, concluding with a plea for getting on with the job of building a prototype vehicle immediately and testing it here on earth. One of the first detailed analyses of such a vehicle, this slim volume deserves the attention of anyone coping with the not-too-distant problem of manned lunar exploration.

Space Age Dictionary (Van Nostrand, 128 pp., $5.95), edited by Charles McLaughlin, offers definitions of common rocket and astronautical terminology. Designed for the educated layman, it is, of course, far too basic for those working in the field. However, it will be helpful to those anxious to learn a little more about terms which they are coming across more and more often in the daily papers and popular magazines. Simple illustrations provide a graphic explanation of some of the terms, while a special 24-page section offers silhouettes of American and Russian missiles.

In **The Unity of the Universe** (Doubleday, 228 pp., $3.95), cosmologist D. W. Sciama offers a clear and interesting survey of this fascinating subject and comes to the conclusion implicit in the book's title. While some may quarrel with this conclusion, it would be difficult to argue with the manner in which the author deals with some very perplexing questions. The first part of the book describes step by step how our present picture of the universe has been built up, starting with early Greek cosmological theories and coming up to the most recent discoveries. The second portion presents a number of contemporary theories about the universe and describes how these theories have developed. Using language which can be understood even by those without any great knowledge of either astronomy or physics, the author has provided the layman with a first-rate introduction to cosmology.

Last May, a three-day symposium on basic research bringing together some 250 leading scientists, industrialists, government representatives, and college officials was held in New York City under the sponsorship of the NAS, the AAAS, and the Alfred Sloan Foundation. Proceedings of the symposium, now available as **Publication No. 56 of the AAAS,** will be of interest to anyone concerned with the future of basic research in this country. Speakers at the symposium (among them J. Robert Oppenheimer, Alan T. Waterman, Lee DuBridge, James R. Killian Jr., Allen V. Austin, and President Eisenhower) all stressed the need for adequate and suitable support for basic research if scientific progress in this country is to continue.

Heinz Gartmann, editor of *Weltraumfahrt,* and well-known German writer on rocketry and astronautics, has written a German biography of **Wernher von Braun** for Colloquium Verlag, Berlin (96 pp., 4.50 DM). In addition, he has sponsored publication of a science-fiction novel in German by one Werner Wehr, actually a pseudonym for a well-known rocket man, entitled **Ich Lebt im Jahr 3000** ("I Live in the Year 3000") (296 pp., Mundus-Verlag, Stuttgart, 14.80 DM), which tells of the journey of a photon-powered space vehicle to the stars. Eugen Saenger provides an introduction and Gartmann himself a postscript explaining photon propulsion.

Last September, Doubleday-Anchor Books offered the first group in a series of more than 70 titles to be known as the **Science Study Series.** Designed to bridge the gap between the scientist and the layman, the series offers to readers a library of the entire physical world. About 15 titles, most of them priced under $1, will be offered each year. The first group of titles includes "Echoes of Bats and Men," by Donald R. Griffin; "The Neutron Story," by Donald J. Hughes; and "Magnets," by Francis Bitter. The Science Study Series is an outgrowth of the MIT Physical Science Study Committee, formed in 1956, with the series conceived as supplementary reading for a new physics course at the high school level produced by the committee.

RECEIVED

Concise Dictionary of Science, by Frank Gaynor (546 pp.), Philosophical Library, New York, N.Y. $10. A rather haphazard book for a dictionary.

Illustrated Guide to U.S. Missiles and Rockets, by Stanley Ulanoff (128 pp.), Doubleday, New York, N.Y., $3.95.

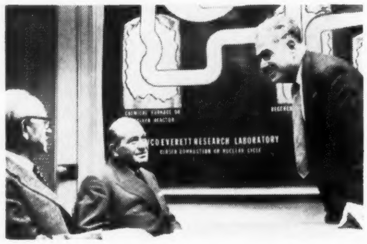
Tomorrow the Moon, by Abraham and Rebecca B. Marcus (150 pp.), Prentice-Hall, Englewood Cliffs, N.J., $3.50. For youngsters.

Power Unlimited, by Abraham and Rebecca B. Marcus (152 pp.), Prentice-Hall, Englewood Cliffs, N.J., $3.50. High school level.

Solion: Principles of Electrochemistry and Low Power Electrochemical Devices, H. B. Reed Jr. and J. B. McQuitty, (46 pp., $1.25, from OTS, Dept. of Commerce, Washington 25, D.C.). Ions in solution bid to replace transistor mediums: NOL report.

Russian for the Scientist, by John and Ludmilla Turkevich (255 pages, D. Van Nostrand, New York, $5.95). ♦♦

Avco Joins Utilities In MHD Research



At the ARS 14th Annual Meeting, Avco announced that ten power companies have joined with it in a program of further research on MHD commercial electric power generation. Above, from right, Arthur Kantrowitz, director of Avco-Everett Research Laboratory, Victor Emanuel, chairman of Avco Corp., and Philip Sporn, president of the American Electric Power Service Corp., which is agent for the utility companies, have a word about the chart outlining an MHD power system. Both coal and nuclear-powered units are being studied to heat and ionize gas for MHD generators, according to Avco.

A Historic Annual Meeting

(CONTINUED FROM PAGE 26)

education, and more than the total spent annually on medical research. It was unlikely that any more money could be spent on space exploration, he added, and thus other ways must be found to increase our effort. Foremost among these is the careful selection of projects, particularly those involving expensive hardware; another is to diversify more and put greater emphasis on relatively inexpensive research, so as not to overlook any good ideas.

The complete text of Dr. Pickering's address will be found on page 27.

Featured speaker at the Honors Night Dinner was AEC Chairman John A. McCone, whose address on "The Influence of Nuclear Technology on Rockets and Space" pointed up some of the special contributions of the atom to the space race. He announced at the Dinner that the George Washington, the Navy's first atomic-powered submarine designed to fire Polaris missiles, had successfully completed her first sea trial; reviewed recent developments in the Pluto and Rover projects; and pointed to successful operation at full power and maximum temperature of the Snap II reactor, which could conceivably supply auxiliary power for space vehicles. The reactor, he noted, weighs about 220 lb and is no larger than a 5-gal milk can, but is designed to supply several kilowatts of power for long periods.

These, then, are some of the highlights of the 14th ARS Annual Meeting—a historic meeting for the Society which, in addition to producing a good deal of technical food for thought, helped in no small measure to bring East and West closer together.

It also produced a memorable crack by Prof. Sedov. It came in reply to a question as to what kind of propulsion the Russians used in their Lunik vehicles. "The most modern kind," he answered.

This might well apply to the meeting itself, for it was, indeed, "the most modern kind" of meeting. ♦♦

Soviet Man in Space

(CONTINUED FROM PAGE 38)

Q: Your film shows rats and mice attempting to adapt to weightlessness in capsule flights. Does the size of the capsule compartment, the size of the animal, the animal's maturity, the kind of an animal—or whatever—affect acclimatization in this kind of flight?

A: Probably the size of the animal should be taken into account. You can see that rats adapted more easily than mice.

Q: Did the rats really adapt to the weightless state or did they just become fatigued?

A: We think they are adjusted, or at least the medical experts said so. The medical experts base their opinion on their experience with rats in training. The rats in general were very easily adapted to different conditions.

Q: Were there protuberances into the cages, which the rats or mice could have perched on, which would give us some comparison between the experiments you have done and the experiments that were done in the U.S. about the same time?

A: He can't answer this question. ♦♦

Fourth AGARD Colloquium On Combustion Set

The AGARD Combustion and Propulsion Panel will hold its 4th Colloquium in Milan, Italy, during the week of April 4, 1960, on the subject, "High Mach Number Air-Breathing Engines." Attendance is limited to those authorized by the AGARD National Delegates or by members of the panel.

Rocket Morphology

(CONTINUED FROM PAGE 43)

imply anything about the source of thrust, although it infers some type of rocket using a nuclear-energy source. An "ion rocket" probably refers to the source of thrust, an ion beam or jet, but it gives no information about the source of energy. It is perfectly conceivable that a rocket could be constructed using a nuclear reactor for the energy source and an ion jet for the thrust and thus, simultaneously, it would be an "ion" and a "nuclear" rocket.

This is not the end of the difficulty because the problem is further complicated by the fact that it seems possible to use a variety of energy converters to transform the energy from its original form to that which is required for thrust production. An example might be nuclear to thermal energy (by a reactor) to mechanical energy (by a turbine) to electrical energy (by a generator) to kinetic energy of charged particles (by an electrostatic accelerator). However, the details of energy conversion and even the specific form of the propulsive substance seem to be of secondary importance.

Thus, to avoid names that become excessively cumbersome, it is suggested that the rocket be called by the source of energy and the source of thrust. For example, there could be a "nuclear-thermal rocket," a "nuclear-ion rocket," a "solar-ion rocket," a "liquid chemical-thermal rocket," and so forth. Reference to the diagram on page 43 will yield other combinations based on the same scheme.

Argument could develop over the solar-photon jet or "solar sail" being a rocket because the propulsive substance is not initially carried on board. It is, in fact, akin to an airbreathing thermal jet, such as a turbojet, because it is a device that changes the momentum of an available "substance" which is, in effect, taken aboard. However, some license must be allowed since it is only a very special case of general solar-energy systems.

Suggested Additional Reading

Dillaway, R. B., "Propulsion Systems for Spaceflight," *Aeronautical Engineering Review*, April 1958, p. 42.

Ehricke, Krafft, "The Solar Powered Space Ship," ARS Paper 310-56.

Garwin, R. L., "Solar Sailing—A Practical Method of Propulsion within the Solar System," *Jet Propulsion*, vol. 28, March, 1959, p. 188.

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♦♦

Missile market

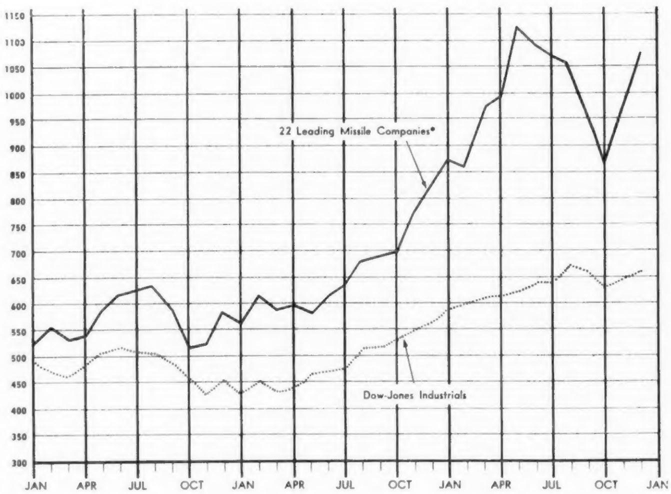
BY JEROME M. PUSTILNIK, Financial Editor

CERTAINLY the last year has been prosperous for most missile industries shareholders. The rewarding 28.4 per cent gain by the Missile Index is more than 75 per cent greater than that of the Dow-Jones Industrials which also appreciated handsomely. But this is not the whole story by any means. The major aircraft companies, for example, have not shared this largesse; in fact, the current market prices of many are below last year's levels. Meantime, and in vivid contrast, electronics, propellant, and research and development concerns have had their securities soar to lofty heights. These same divergent trends were encountered again last month as the Missile Index sped ahead to a stirring 11.4 per cent. Many lower priced securities, glibly if inaccurately identified with the missile industries, raced ahead of the Index, doubling, even tripling in market price—often in only a few days time. In the past, such racy (in all its connotations) performances have shown that a clear and present danger exists.

It is just as traditional at this time of year to polish up the old crystal ball as it is to review the old year, and ask —How will the Missile Index fare in 1960? Two basic considerations will determine the answer and they are (1) the outlook for the economy and (2) prospects for missile business.

Although labor unsettlement in such basic industries as steel and railroads still shroud the economy's future, they cannot entirely obscure the bright business picture for 1960. Gross national products should set a new high of $509 billion, up $29 million from 1959's level, with consumer purchases and business spending for new plant and equipment slated to be most vigorous areas in the economy. Financial observers and most economists agree these forces will propel the economy to new high ground for at least the first 9 months in 1960 and, perhaps, for the full year. A degree of economic unsettlement and some recessionary influences may be encountered thereafter. Any recurrence of the steel strike or a major railroad labor-management debacle would, of course, scramble these projections. Relating these economic ideas to the stock market, it is important to remember that historically the market tends to discount major economic changes 3 to 6 months in advance. Accordingly, a critical re-examination of the economy and the market's behavior should be made at midyear. Until then, record business activity should advance hand-in-hand with the stock market for the first 6 months of 1960.

THE MARKET AT A GLANCE



*Index compiled June, 1955

	December 1959	November 1959	% Change	December 1958	% Change
Dow-Jones Industrials	659	647	+ 1.9	560	+17.7
Missile Index	1076	966	+11.4	838	+28.4

As for investment in missile stocks, unfavorable trends are developing. A ceiling of about $41 billion has been placed on next year's defense budget—at the very moment missile and related weapons system progressively grow more complex and, therefore, more expensive. This means a smaller number of programs can be financed; and *that* means fewer major contracts will be awarded. Paralleling this policy is the military's decision to authorize many different R&D projects at the expense of production contracts. This policy hobbles the industry's profits because R&D contracts are on cost-plus-fixed fee basis, whereas production contracts specify a unit price that usually results in a higher profit margin. Finally, with fewer major contracts let, prime contractors will tend to do more work within their own plants, to the detriment of their subcontractors.

Can the pendulum swing the other way? Perhaps. An increased defense budget would provide quite a push; or it might happen if the ground swell in the press favoring this action exerts enough pressure. Spectacular new Russian successes in space might force this development. Another consideration is that in 11 months a new president will have been elected and he might advocate significantly higher spending. But, in the meantime, these confusions and uncertainties, while providing many opportunities for the enterprising trader, comprise an unfavorable investment climate for the missile industries.

The speculative frenzy and wild price advances that have whirled about some electronic and missile securities in recent weeks, particularly very low-priced issues, alarm stock market veterans, traders, and investors. Ex-

(CONTINUED ON PAGE 92)

Pilot shows off Zuni, with its sturdy blast-operated folding fins and forward ignition ring without external lead. The solid propellant rocket is carried in four-round external store launchers.

Navy's Zuni Missile In Mass Production

The Navy's long-awaited general-purpose aircraft rocket Zuni is now in mass production for the fleet. Designed and developed by the U.S. Naval Ordnance Test Station (NOTS), China Lake, Calif., the 5-in.-diam unguided solid-propellant rocket can be fired air-to-air or air-to-ground in various combinations from four-round external-store launchers, and can carry a general-purpose shaped charge, slug, or heavy-burst warhead, as appropriate to the target. Apparent from the photo are its single nozzle with blast-operated folding fins and forward ignition ring without external lead. The general-purpose warhead with shaped charge makes the rocket highly effective against a wide range of ground targets, such as heavy tanks, heavy bunkers, small ships, parked aircraft, ammunition dumps, troop concentrations, and the like.

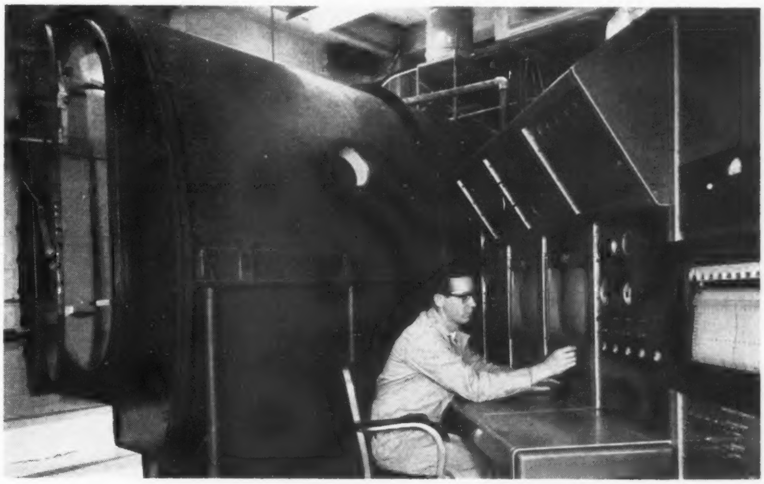
Metal parts for the rocket motor are being produced by Bridgeport Brass Co. of Riverside, Calif. The rocket's motor tube is a high-strength aluminum alloy.

High High-Pressure Standards

A new pressure-standards program at the National Bureau of Standards will investigate properties of materials to provide more precisely determined calibration points on a pressure scale ranging far above the million-psi mark.

Space Cabin Simulator Delivered to Air Force

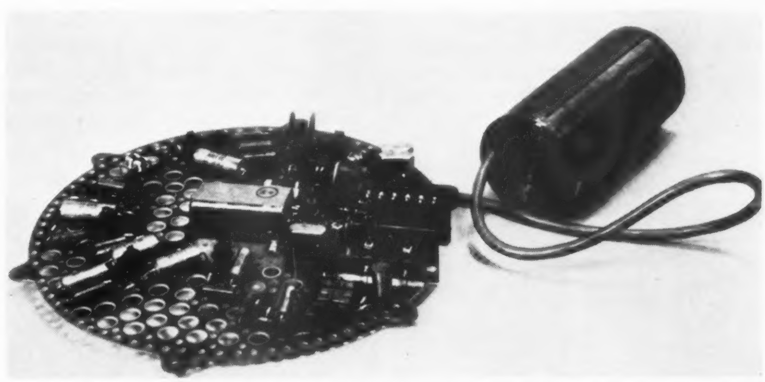
The pictured space-cabin simulator, delivered recently to the AF School of Aviation Medicine at Brooks AFB, Tex., by Minneapolis-Honeywell Regulator's Aeronautical Div., will be able to test two men for 30 days under conditions closely approximating those of spaceflight. The cabin's equipment automatically recycles atmosphere to regulate its composition and to reclaim respired water vapor. Pilots will eat nonperishable food. Solid wastes will be burnt and gases discharged from the system. Liquid wastes will be reclaimed chemically. The Air Force has a number of carefully screened volunteers ready for simulated flights in the chamber.



Panel at right monitors all functions of cabin (left, confines 8 x 12 ft) and covers occupants with closed-circuit television.

Vanguard III's Magnetometer

Vanguard III carries a unique magnetometer invented by the late Russell Varian of Varian Associates. A cleverly conceived instrument, it consists chiefly of a switching circuit, an amplifier, and a coil of wire, all immersed in a liquid containing hydrogen atoms (protons), such as the hexane used in Vanguard III. These protons precess like gyros about the earth's magnetic field, and doing so induce a current in the coil. The frequency of this current is directly proportional to the strength of the field, thus giving a measure of it, and can be easily telemetered to the ground. The Varian magnetometer is the only one producing data directly in the form of an audio signal. Moreover, it can be used in any position and needs no calibration. It was for these reasons chosen for the Vanguard III.



Shown here unencapsulated, the Varian proton free-precession magnetometer weighs 30 oz in its transistorized form for Vanguard III. The sensing head, at right, encases the coil and proton-containing fluid, hexane in this application.

People in the news

APPOINTMENTS

Thomas S. Gates Jr., a former Secretary of the Navy, and Deputy Secretary of Defense for the past six months, has been appointed to succeed Neil McElroy as Secretary of Defense.

Col. William M. Davis will head the new weapon system project office in charge of managing Dynasoar at Air Materiel Command's Aeronautical Systems Center. His civilian deputy will be **Peter J. DiSalvo**, former deputy chief of AMC's F-108 WSPO.

Maj. Gen. Clyde H. Mitchell, formerly commander of Rome (N.Y.) Air Materiel Area, has been appointed commander of Air Materiel Command's newly activated Electronic Systems Center, Hanscom Field, Bedford, Mass., and also supervisor of Electronics Defense Systems Div. in New York City until it is absorbed by the new Center early this year. **Brig. Gen. Charles B. Root**, chief of EDSD, succeeds Gen. Mitchell at Rome.

Comdr. Robert F. Freitag, Pacific Missile Range Officer, NAMTC, Pt. Mugu, has been transferred to head the Navy's R&D program for satellites and space systems as astronautics officer in the newly formed Bureau of Naval Weapons.

AEC has announced the appointment of **Brig. Gen. Irving L. Branch**, USAF, as assistant director for Aircraft Reactors, Div. of Reactor Development.

Bowen C. Dees succeeds Harvey C. Kelly as director of the National Science Foundation for Scientific Personnel and Education, while **Dr. Kelly** becomes associate director of scientific education. **Richard H. Bolt**, on leave from MIT, has replaced Robert S. Brode as associate director of research. Dr. Brode, who is returning to the Univ. of California, will continue on as special consultant to the director.

Herbert R. J. Grosch, formerly manager of Space Programs, Advanced Programming for IBM's Military Products Div., and a past-president of ARS, has joined C-E-I-R, Inc., as director of corporate programs and planning.

John J. Wagner, formerly on the Los Alamos Scientific Laboratory staff, has been appointed staff scientist at Marquardt's Nuclear Systems Div.; **A. O. Mooneyham** becomes manager, Nuclear Projects Dept.; and **Milton M. Weintraub**, manager, Controls Engineering Dept.

Arthur L. Markel has been named Washington representative for the Anti-Submarine Warfare Div. of Aerojet-General, replacing **Harold F. Osborn** who returns to Azusa to become manager of the Western State Office.

Mostafa B. Talaat has joined the Nuclear Div. of Martin-Baltimore where he will direct all research and development in the field of energy conversion.

Sam L. Ackerman, senior project engineer on the Atlas program, has been named to the new post of program director of electronic products for Convair. **George J. Vila** becomes manager-NASA for the division.

Douglas Aircraft has appointed **Charles R. Able** vice-president, defense programs and **J. R. McGowen**, vice-president, commercial programs, two new corporate functions. **A. V. Guillou** and **Peter Horton** have been named director of marketing, defense programs, and director of plans-defense programs, respectively. **A. E. Raymond**, senior vice-president, engineering, will have over-all responsibility for the new Advanced Research Organization, which **Charles R. Strang** will head.

James S. McDonnell Jr., president of McDonnell Aircraft, has been elected chairman of the Board of Governors, Aerospace Industries Assn. **Elmer P. Wheaton**, vice-president, engineering, missiles and space systems for Douglas, has been elected chairman of the Association's newly organized Guided Missile Council.

John H. Reifel, former director of the Engineering and Development Div., Wyandotte Chemicals Corp., becomes director of the newly formed Corporate Development and Planning Div.

Nucleonics, a new engineering subdivision at Rocketdyne, will be headed by **R. B. Dillaway**, who will be responsible for developing capability in nuclear and electrical propulsion, and power conversion systems.

Olin Mathieson has appointed **Vergil S. Saine** director of solid propellant operations, Ordill plant, and **John W. Churchill** director of research for the Energy Div. at New Haven, Conn.

Frank Genevese, former assistant manager, Propulsion and Fluids Research Dept., Armour Research Foundation, has joined the Applied Science Div. of Fairchild Engine and Airplane Corp. as manager of operations research.

Walter Unterberg, former supervisor of the Thermodynamics Development Group at Marquardt, has been named manager of the Thermal Power Section at Sundstrand Corp.'s Turbo Div.

Clifford R. Crusan has been appointed president and general manager of Turbocraft, Inc.

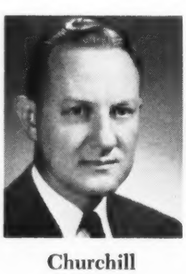
Israel J. Melman has been made director of a new solid state laboratory established by Servo Corp. of America.

At Solar Aircraft, **Morris Lebovits** has been promoted to chief of astroaero sciences; **Ben C. Axley Jr.** has been named chief of avionics in the R&D Engineering Div.; and **Bertram Klein** is new chief of structures. **Brian M. Gallagher** has joined the company as senior design engineer.

American Bosch Arma has assigned **Bernard Litman** to direct flight tests of its all-inertial guidance system in the AF Atlas ICBM program at Cape Canaveral.

Howard Percy Robertson, professor of mathematical physics at CalTech and a member of President Eisenhower's Scientific Advisory Committee, has been elected to the board of

◂ Saine



Churchill

Crusan

Melman


Shonerd


Campbell


Kahn


Register


Holmes


Magasiny

directors of Northrop Corp. **Edgar F. Vandivere** joins Page Communications Engineers, Inc., a Northrop subsidiary, as consultant to the director of R&D.

Jerome Belsky has been named vice-president of manufacturing, test, and building and grounds for Grand Central Rocket Co.

Col. J. C. Pitchford (AF-Ret.) has been appointed vice-president in charge of engineering at Benson-Lehner Corp.

Arthur H. Attebery has been appointed chief of engineering services at Ryan Electronics Div. of Ryan Aeronautical, and **V. M. Bennett** manager for Army Projects. **W. P. Sloan** has been made manager of aircraft requirements in the Military Relations Div., San Diego, while **James W. Wells** succeeds Sloan as manager of Ryan's Washington office.

Charles M. Read has been appointed chief service engineer, Field Service Dept., Republic Aviation.

Richard Holbrook, formerly assistant chief, Defense Analyses Branch of the Institute of Missile Defense, ARPA, has returned to Rand Corp. as associate head of the Operations Dept., Engineering Div.

David E. Shonerd, assistant program director of maintenance at Space Technology Labs, has joined Rocket Power, Inc., as vice-president, engineering.

Donald M. McGrath becomes vice-president and general manager of Siegler Corp.'s Hufford Div.

D. H. Steinweg will head the new Medical Electronic Section of Nems-Clarke Co.

Robert A. Fuchs has joined Electro-Optical Systems, Inc., as principal scientist and head of the systems analysis group of the Space Defense Systems Div. **Virgil N. Cosma** has joined the SDS group. **Frederick E. Fuller** becomes a member of the senior technical staff, assigned to the Energy Research Div.

Patrick N. McDuffie will represent General Precision Equipment Corp. as technical coordinator at Redstone Arsenal.

Joining the Plans and Program Group of Hercules Powder Company's Chemical Propulsion Div. are **Austin B. Chappelle,** formerly chief engineer for propulsion at Martin-Orlando; **William D. Kelley Jr.,** previously manager of quality control in Thiokol's Utah Div.; and **John A. Scherer,** from Westinghouse Electric's Advanced Systems Planning Group.

Nicholas F. Pedersen has joined the Aero Hydraulics Div. of Vickers-Detroit, as executive engineer, major programs, and **Mel Pfeifer** has been appointed staff engineer at Vickers-Waterbury.

Philip H. Young has been promoted to assistant chief engineer of Space Recovery Systems, Inc., and will also direct the newly formed Applied Projects Group in the development and manufacture of escape and recovery systems.

Samuel Levine has been appointed to the newly created post of director of engineering and research for the Defense Products Div. of Fairchild Camera and Instrument Corp.

Richard A. Campbell has been elected vice-president in charge of operations of Pacific Semiconductors, Inc.

Wolfgang G. Pfeiffer has been appointed senior research engineer, National Cash Register Co.'s Electronics Div.

Marvin J. Kahn has been promoted from assistant director of engineering to director of the newly organized Plans & Programs Div. at Aircraft Armaments, Inc.

Charles L. Register has been promoted to program manager, ALRI (Airborne Long Range Input), Burroughs Corp., with responsibility for management of the company's new $35 million AF contract.

O. G. White has been appointed director of procurement for Chrysler Corp.'s Defense Operations Div., succeeding **A. H. Hilverkus,** who has been named to the newly created position of special assistant to the division general manager.

Southwest Research Institute has named **Maj. Gen. Harry Reichelderfer** (USA–Ret.), administrative vice-president; **James Sharp** and **Henry Korp** have been named technical vice-presidents.

Bendix Aviation's Products Div. has appointed **Richey W. Whitesell,** assistant general manager and acting director of marketing; **Rudolph Bodemuller,** director of engineering; and **Frank E. Bremer Jr.,** director of reliability and quality. At Mishawaka, **Stephen P. Sanders** has been promoted to chief of Environmental Testing Laboratory of Bendix Products Div., Missiles.

Leach Corp. has appointed **R. S. Anderson** manager of the Special Products Div.

Edward L. Swainson, formerly chief engineer, Components Dept., Military Products Div., American-Standard, has been upped to technical assistant to the president of the division.

Paul J. Weber will head the Instrumentation Products Div., Ampex Data Products Co., while **James D. Bowles** will manage the Computer Products Div.

William C. Holmes, formerly assistant weapon systems manager and administration director, WS-117L Satellite Program, Lockheed, has been appointed vice-president and manager at Radiation, Inc.'s Space Communications Div. At the Levinthal Electronic Products subsidiary, **Albert J. Morris** has been appointed senior vice-president, engineering. Succeeding Morris as chief engineer is **Harry G. Heard,** former staff member of the Univ. of California's Radiation Laboratory.

Irving P. Magasiny joins Schaevitz Engineering as director of engineering.
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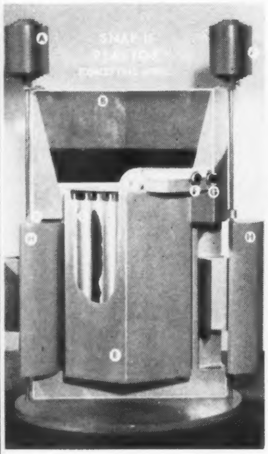
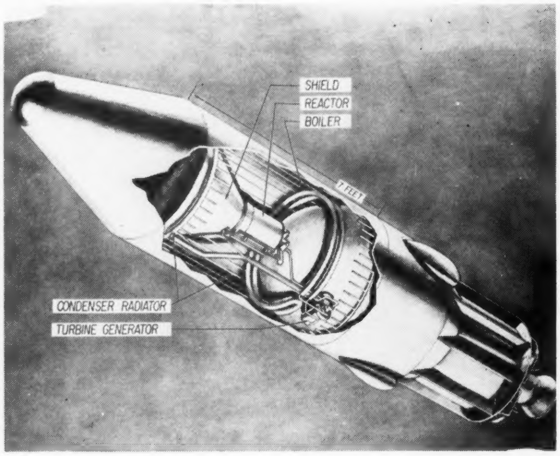
Snap II, Atomic Reactor for Space





Left, a cutaway model of Snap II shows major components, keyed by letter: (A) control drive motors, (B) integral shielding, (C) fuel elements, (D) reflector, (E) reactor-core vessel, (F) coolant inlet, (G) coolant outlet, and (H) control drums. Center, Snap II as it might appear in a typical satellite application. Right, an Atomics International engineer examines a Snap II reactor. In operation, the reactor would be activated after a satellite was definitely in a stable orbit.

At the ARS 14th Annual Meeting, the Hon. John A. McCone, chairman of the AEC and the featured speaker at Honors Night, announced Snap II, a 220-lb reactor developed specifically for space applications by NAA's Atomics International Div. for the AEC. Coupled with a football-sized turboelectric generator developed by Thompson Ramo Wooldridge, Snap II will be capable of providing about 3 kw of electrical power for more than a year. The reactor has already been operated at full power in tests. Much remains to be done, however, in study of the reliability of the Snap II system, and a decision is still pending on the use of such reactors in satellites, which eventually will re-enter the earth's atmosphere and produce radioactive debris. The AEC's new Nuclear Safety Board will review this.

Space Program

(CONTINUED FROM PAGE 27)

formed to set up a U.S. space program; but it seems that every time there is another Russian shot the question is still asked "Do we have a space program?" Also, "When are we going to catch up with the Russians?"

Now, if we stand back and ask the first question without regard to any other facets of world history, the answer is obviously "yes, we have a space program." There is a sum of money on the order of half-a-billion dollars a year being spent on such a program, so we must certainly conclude that the U.S. does, in fact, have an active space program. I think the question which we really need to ask is not "Do we have a space program?" but "Do we have the *right* space program?" In order to answer that, we must ask ourselves "What are the ground rules by which we determine what is the right space program?"

Back in preSputnik days before the cold war campaign in outer space, we had an IGY space program. I think that most scientists associated with that program visualized it as being a program with relatively few shots of space vehicles having payload capacities measured in the few pounds (or perhaps a few tens of pounds). I think they visualized this state of affairs as existing for a few years and then gradually evolving into large space vehicles, lunar exploration, and planetary exploration. Only a few enthusiasts were concerned with the rate of advance of our space capability and with the rapid development of large space vehicles.

Sputnik's Initial Effect

Sputnik immediately changed the picture. But the very hysteria engendered by the first Russian space shots encouraged us to listen to the most wildeyed visionaries, with the result that as far as the public was concerned they expected miracles in the area of space technology almost overnight. They do not realize the real costs or the time factors in the campaign to be waged, and therefore they become more confused and disheartened as time goes on.

Shortly after Sputnik, Dr. Killian's committee presented a Space Primer, in which four objectives for space exploration were presented. These were, in brief, (1) scientific, (2) commercial, (3) military, and (4) human objectives. Now, it would appear to me that the Killian Space Primer omitted the most important immediate objective, and that is, simply, the objective to equal or exceed the achieve-

ments of Russia in space. In other words, we should frankly admit that we are indeed in a race with the U.S.S.R.

If it is a race, one can ask the question "For what are we racing?" Is it for military domination of space? Is it for scientific discovery? Or for commercial exploitation of space? Or is it for our national stature and prestige in the world? I believe the last reason is the most important; and not by any means solely for reasons of nationalistic pride, but rather for very hardheaded, economic reasons.

During much of the Twentieth Century, the world has looked at the U.S. as being the leader in technology and in engineering. At this time, to much of the world the question is now: "Is it Russia or is it the U.S. which is the technological leader?" As a consequence, many decisions affecting our economic welfare are being made against a background of U.S.S.R. achievement and development in this area.

As far as the rest of the world is concerned, it is perfectly clear that we are in a space race with Russia. We have clearly stated that we are undertaking space developments and space exploration. It is also perfectly clear that in the postSputnik era we have not within these two years succeeded in matching Russian achievements.

We must either pursue our space developments actively and successfully or we must declare ourselves completely out of the space race.

Ground Rules

Viewed in this framework, it appears to me that the U.S. space program must be written with the following ground rules: First, the U.S. public must understand the importance of our space program, the time and effort required to conduct the program and the fact that miracles will not occur over night. Secondly, we must establish national objectives clearly to set up a mainstream of dramatic achievement as well as a broad base of exploration and exploitation. Finally, we must establish the management and the funds to properly support, on a long-term basis, our real national objectives.

Within this framework of space objectives, then, if you ask "Do we now have a space program?" the answer must be "No." In the first place, I believe there is a lack of public understanding of the significance of our space program, of the necessity for the program, of the objectives of the program. There is public confusion as to the results of the program, and even of what we should be trying to do. Does the public think we must establish a base on the moon? Or do they think we are trying to do a cosmic ray experiment? Or are we just copying everything the Russians do? Or, indeed, should we have a military space program, a civilian space program, or both?

I believe there is also a lack of broad governmental understanding of national objectives. The questions of the relative priority of military and civilian programs are not clear; and, indeed, interservice and interagency rivalry for scarce funds, facilities, and manpower is certainly occurring.

At this time, what can we do to rectify the situation? As a nation, I think that we must establish our long-term goals in our own space exploration program and then quit jumping every time the Russians fly another space experiment. We must establish goals which are susceptible of engineering achievement and which will provide significant and dramatic progress in space. Then, it is also necessary for us to clarify management responsibilities and priorities in our space program. We do not necessarily have to have a single space program, but we must clearly understand in what areas we can afford the luxury of parallel approaches and peripheral projects. As individuals, as professional engineers and scientists, it appears to me that our task is to educate the public and Congress to the realities and the needs of a national space program; not only to the technical realities of space, but also the realities of the time and money required to accomplish results. Then, of course, we must with patience and understanding encourage and support those who are actively working on the program. It is always difficult to be in second place in this kind of contest, particularly when our every move is made in clear view of our opponent. Success will only come as a logical consequence of public understanding, public support, and hard engineering progress.

Public Is Awakening

This public understanding, it seems to me, is imminent. There are increasing signs that the public is vaguely discontented and embarrassed by our position in the space race and that it soon will make its voice heard.

A Los Angeles newspaper, the *Mirror News*, for example, undertook a public opinion poll last month in which it asked its readers to reply to a 10-point questionnaire and mail it in to the editorial offices.

In the first week, more than 2000 readers went to the trouble of filling out the questionnaire and mailing it in. This is 40 per cent in excess of the response to a similar survey undertaken by the same publication on Los Angeles smog, and I think most of you know the public opinion rating of smog in Los Angeles.

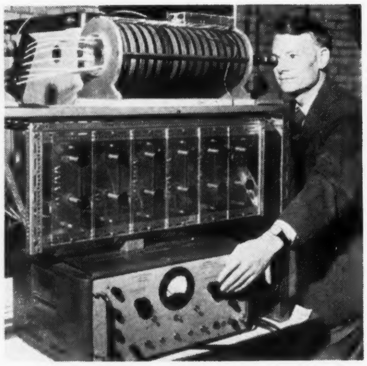
In the returns, three out of every four persons said they are "ashamed" of our position as opposed to Russia in the space program, and six out of every ten said they wanted the U.S. to catch up even if it means reducing our standard of living. Most significantly, more than 50 per cent said they are willing to pay an additional $50 a year or more in income taxes, if the money is allocated directly to the space effort.

A majority agreed that the main danger in lagging is that other nations will decide that Russia, and not the U.S., is the nation to copy.

To all of us, this should be encouraging news. It means that the people of this country, who are in the end charged with the responsibility, have awakened to the danger inherent in this cold war and are about to ask that something be done about it.

When this occurs, I think our troubles will disappear and our programs will fall into place. ♦♦

For Snapshots Of the Planets



Peering into an intensifier that makes optical images 50,000 times brighter is W. L. Wilcock of Imperial College of Science, London, who developed the instrument with his co-worker D. L. Emerson. This image intensifier will permit taking pictures of planets and stars without lengthy exposure time, and thus largely overcome distortions introduced in most picture-taking by local disturbances in the earth's atmosphere. New and exciting pictures of Mars and Venus, for instance, can be expected from use of the instrument.

Government contract awards

GE Gets $101-Million Contract For Advanced Re-Entry Vehicles

The Air Force has announced the award of a $101,000,000 contract to General Electric for continued development of advanced re-entry vehicles for ballistic missiles. According to the company, it is the largest AF cost-plus incentive-fee type of contract ever awarded.

Kearfott Awarded Contracts For Comparators, Pershing

Kearfott Co. Inc. has received a 3-phase contract from WADC's Weapons Guidance Lab for a solid-state multiheaded celestial comparator. Initial funding of $99,800 for the study phase has been received by the company; phase 2 is to design and build a feasibility model; and phase 3 is for the building of a flight operational prototype. In a second pact, Kearfott also received an ABMA contract to design, develop, and build hydraulic control systems for the Pershing missile.

Navy Polaris Contract

The Navy has awarded Westinghouse Electric Corp. a $5,250,000 contract for continued work on Polaris missile launching systems.

Rocket-Fuel Research

The Army has awarded a $1,722,000 contract to Esso Research and Engineering Co. for research work on solid rocket fuel.

Celestial Mechanics Study

The new Institute of Space Sciences at the Univ. of Cincinnati has received a $178,000 NASA contract for research in celestial mechanics, involving improvement of techniques to be used in orbit determination of satellites and space probes.

Microwave System

Collins Radio Co. has received a $2,000,000 Air Force contract for the engineering, manufacture, and installation of a microwave communication system for ICBM control activities and launch sites in the Fairchild AFB area near Spokane, Wash.

Road Maps in Space

Studies to determine paths of orbiting and interplanetary vehicles have been undertaken by GE's Missile and Space Vehicle Dept. under contracts from the Army's Ballistic Research Laboratory, the Air Force's Wright Air Development Center, and Air Force Cambridge Research Center.

Speech-Compression System

Melpar's Communication and Navigations Systems Engineering Dept. has been awarded a $550,800 contract by Wright Air Development Center to conduct a study program to advance the state of the art for a digitalized bandwidth-compression system and to develop and construct five 2-way digitalized speech-compression systems.

Burroughs Wins ALRI Contract

The Air Material Command has announced that Burroughs Corp. has won out in competition with eight other firms for systems management work for the Airborne Long Range Input (ALRI) contract, which in the early stages will amount to about $35,000,000.

Skyhawk Supplemental Pact

Douglas Aircraft has received a $58.8 million supplemental Navy contract for further production of the A4D-2N Skyhawk aircraft.

Project Vega Contract

A $400,000 contract to develop and manufacture digital programers and groundbased checkout systems for Project Vega has been awarded to Telemeter Magnetics, Inc., by JPL.

Ryan Gets $10 Million Contract

A follow-on contract in excess of $10 million has been awarded by the Air Force to Ryan Aeronautical Co. for production of additional Q-2C Firebee jet-propelled target systems.

Minuteman Communication Study

A $118,000 study contract for Minuteman launch-control-system communication techniques, involving the feasibility of low, medium, and high frequency systems, has been awarded to GE's Heavy Military Electronics Dept.

Saturn Launch Facilities

Successful bidder for the $4,321,658 Army construction contract for Saturn launch facilities at Cape Canaveral was Henry C. Beck Co. of Palm Beach, Fla.

Modified Jupiters

Chrysler Corp. has contracted to provide modified Jupiters to AOMC for use as target missiles in the Nike-Zeus anti-missile missile program.

Ultra-HF Receiver

Sylvania Electric Products has announced receipt of a $450,000 WADC

NASA CONTRACTS FOR SEPTEMBER

Contractor	Obligation	Program
Avion Div., ACF Industries, Inc.	$ 50,000	Radar tracking beacons for Scout.
Bendix Radio Div., Bendix Aviation Corp.	$2,000,000	Operation of Minitrack stations for 1960.
Geophysical Corp. of America	$ 110,000	Instrumentation to measure electron density in the ionosphere.
Instituto Geofisico de Hyancayo	$ 110,000	Operation of tracking and receiving station at Lima, Peru.
Minneapolis-Honeywell Regulator Co.	$ 140,000	Fabrication of a guidance and control system for Scout.
Pratt & Whitney Div., United Aircraft Corp.	$ 100,000	Investigate heat-transfer potentialities of a number of materials in a near-vacuum under extremely high temperatures that would be encountered in a nuclear-electric generating system.
Republic Aviation Corp.	$ 73,000	Study of lunar and interplanetary space probe trajectories.
Society of Photographic Scientists and Engineers	$ 50,000	Operational expenses foi volunteer photo and radio tracking of earth satellites.
Thiokol Chemical Corp.	$ 50,000	Spherical rocket motors for re-entry research.
Univ. of Michigan	$ 90,000	Basic research on the plumbing erosion that occurs under high temperatures in certain rocket engines.

contract for an experimental all-semiconductor ultra-high-frequency airborne radio receiver that will provide 10,000 hr of continuous operation and will be adaptable to microminiaturization.

Polaris Inertial System

Dynamics Research Corp. has received a $73,338 prime contract extension for investigations of system organization and operation of the Polaris submarine inertial navigation system, under study for the past two years.

Radar Data Handling Systems

NASA has let a $207,000 contract to Electronic Engineering Co. of California for three systems of electronic data handling equipment to be used at Wallops Island.

SYNOPSIS OF AWARDS

The following synopsis of government contract awards lists formally advertised and negotiated unclassified contracts in excess of $25,000 for each Air Force, Army, and Navy contracting office:

AIR FORCE

AF Cambridge Research Center, Laurence G. Hanscom Field, Bedford, Mass.

Research on the application of electron beam machining techniques to semiconductors, $34,160, **Stanford Research Inst.**, Menlo Park, Calif.

Research directed toward the investigation of auroral and lunar reflected signals, $74,975, **Cornell Aeronautical Laboratory, Inc.**, 4455 Genessee St., Buffalo, N.Y.

AF Missile Test Center, Patrick AFB, Fla.

Increase in funds, $38,200, **Lenkurt Electric Co., Inc.**, 1105 County Road, San Carlos, Calif.

Air Force Office of Scientific Research, Washington 25, D.C.

Behavioral sciences, information detection, $61,792, **Univ. of Michigan**, Ann Arbor, Mich.

Behavioral sciences, performance of small groups, $43,389, **Human Sciences Research, Inc.**, Arlington, Va.

Behavioral sciences, motivation, $28,-493, **Ohio State Univ.**, Columbus, Ohio.

Behavioral sciences, man-machine aspects of decision making, $70,000, **Univ. of Michigan**, Ann Arbor, Mich.

Flame spectroscopy, $45,788, **Cornell Univ.**, Ithaca, N.Y.

Photometric titration, $41,828, **Univ. of Kansas**, Lawrence, Kans.

Hot atom chemistry, $64,940, **Johns Hopkins Univ.**, Baltimore, Md.

Dynamic effects of mass and stresses, $30,208, **Rensselaer Poly. Inst.**, Troy, N.Y.

Arc-heated, low-density tunnel, $25,-000, **Univ. of California**, Berkeley, Calif.

Nuclear physics, properties of hyperfragments, $80,458, **Univ. of Chicago**, Chicago, Ill.

Nuclear physics, quantum electrodynamics, etc., $150,000, **Stanford Univ.**, Stanford, Calif.

Physics, gases at high temperatures, $29,000, **Columbia Univ.**, New York, N.Y.

Physics, sampled-data control systems, $27,182, **Univ. of California**, Berkeley, Calif.

Solid state sciences, precision X-ray spectroscopy, $190,000, **Cornell Univ.**, Ithaca, N.Y.

Research Contracting Officer, Transportation Research Command, Fort Eustis, Va.

Preliminary design study and design and construction of a laboratory scale thermoelectric generator for appliances beyond the earth's atmosphere, $26,649, **Curtiss-Wright Corp.**, P.O. Box 110, Princeton Div., Princeton, N.J.

Dayton AF Depot, Gentile AF Station, Dayton 20, Ohio.

Flight test data processor, $100,000, **Melpar, Inc.**, 3000 Arlington Blvd., Falls Church, Va.

ARMY

Army Ordnance Dist., Birmingham, 2120 Seventh Ave., N. Birmingham 3, Ala.

Engineering and design services, ground support equipment, Saturn, supplement, $306,000, **Hayes Aircraft Corp.,** P.O. Box 2287, Birmingham, Ala.

Research and development of test cones for nose sections, $70,646, **Westinghouse Electric Corp.,** Micarta Div., Hampton, S.C.

Lacrosse missiles and related equipment, supplement, $5,477,171, Martin Co., Sand Lake Road, Orlando, Fla.

Army Ordnance Dist., Los Angeles, 55 S. Grand Ave., Pasadena, Calif.

Design and development of motor, $235,000, **Rocketdyne,** 6633 Canoga Ave., Canoga Park, Calif.

Study of radiation on missile components, $49,490, **Hughes Aircraft Co.,** Culver City, Calif.

Rocket engines, $261,700, **North American Aviation,** 6633 Canoga Ave., Canoga Park, Calif.

Army Ordnance Missile Command, Redstone Arsenal, Ala.

Thermal imaging systems, $48,266, **Radiation Electronics Corp.,** 8241 N. Kimball Ave., Skokie, Ill.

Pressure transducers, $29,775, **Bourns, Inc.,** 6135 Magnolia Ave., Riverside, Calif.

Army Signal Supply Agcy., 225 S. 18th St., Philadelphia 3, Pa.

Surveillance drones, $2,300,054, **Radioplane,** Div. of Northrop Corp., Van Nuys, Calif.

Boston Ordnance Dist., Army Base, Boston 10, Mass.

Engineering study of satellite tracking system, $152,175, **Sylvania Electric Products, Inc.,** Waltham, Mass.

NAVY

Navy Bureau of Aeronautics, Washington 25, D.C.

Furnish engineering services and materials necessary to conduct the Regulus I weapon system support program, $95,000, **Chance Vought Aircraft,** Dallas, Tex.

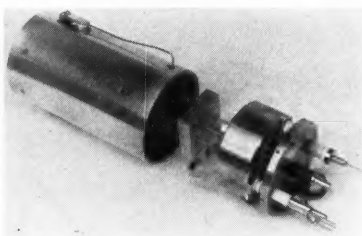
Navy Bureau of Ships, Washington 25, D.C.

Design and construct a series of bladeless propulsion systems of the duct-type, $40,775, **Rensselaer Polytechnic Inst.,** Troy, N.Y.

Office of Naval Research, Washington 25, D.C.

Research in hybrid combustion, $59,686, **North American Aviation,** Canoga Park, Calif. ♦♦

For Testing in Space



The photo shows an exploded view of a 2-lb prototype model of a 2-millipound-thrust ion engine under study at Electro-Optical Systems Inc. This small engine, launched as part of a satellite, might provide actual figures on ion-engine performance and reliability, now unobtainable with laboratory-simulated space environment.

Radio Standards Studied

The NBS Radio Standards Laboratory, Boulder, Colo., is expanding its program of radio-standards research and calibration services. Space exploration is one field that has strained current radio standards.

Meteorological Rocket Network

Rockets are now being launched to gather data on atmospheric wind, temperature, and density and other meteorological information at Ft. Churchill, Canada, White Sands, N.M., Ft. Greeley, Alaska, Wallops Island, Va., Cape Canaveral, Fla., and the Pacific Missile Range, Calif. The Pacific Missile Range, with headquarters at Pt. Mugu, began routine, scheduled launchings of high-altitude Arcas and Loki sounding rockets last fall and will continue this spring.

Plastics Meeting Aimed At Space Engineering

The 16th National ANTEC Meeting of the Society of Plastics Engineers, to be held Jan. 12–16, 1960, at the Conrad Hilton Hotel in Chicago, will have several sessions especially devoted to development and production engineering of plastics for aircraft and space applications.

Filing for Guggenheim Fellowships

Applicants for 1960–1961 Daniel and Florence Guggenheim Fellowships must file forms and credentials with Princeton Univ., CalTech, or Columbia Univ. by March 1, 1960. As many as 18 fellowships will be granted this spring, each providing both tuition and a stipend of $1500 to $2000.

People in the News

(CONTINUED FROM PAGE 80)

Lloyd P. Smith, former president, Avco Research and Advanced Development Div., and a director of Avco Mfg. Corp., has joined Aeronutronic as director of research operations.

Maurice Nelles has joined American Electronics, Inc., as vice-president, engineering.

Joseph Carlstein has been named chief engineer of Norden Div.'s Ketay Dept., Commack, N.Y.

John R. Long becomes chief test engineer of Aluminum Co. of America's Cleveland development division.

A. L. Scharff has been promoted from manufacturing manager to general manager at Magnetic Research Corp.

Nicholas H. Johns has been named executive engineer, R&D Dept., Data-Control Systems, Inc.

At Hoffman Electronics, **Jack Kuhner** has been appointed general manager, Hoffman Laboratories Div.; **Frederick J. Seufert** becomes section manager of the division's newly established Systems Development Section, while **James C. Creswell** succeeds Seufert; and **Robert J. Gilson** becomes program director of the ULD-1 "Tall Tom" program.

Charles H. Bredall, formerly with RCA, has joined the Technical Products Div. of Packard Bell Electronics as senior project engineer, advanced techniques.

C. P. Pesek, Minnesota Mining & Mfg. Co. vice-president for engineering and staff manufacturing, has been elected to the company's board of directors.

William H. Newell has been appointed assistant to the president of Ford Instrument Co., Div. of Sperry Rand.

General Motors has elected **Harold R. Boyer** a vice-president and appointed him general manager of the Defense Systems Div., a new activity headed by executive vice-president **S. E. Skinner.**

Ivar C. Peterson has been appointed assistant to the president of Lear, Inc.

Robert T. Watson has been named associate director of ITT's Components and Instrumentation Laboratory.

IBM has appointed **G. H. Rathe Jr.** director of market planning on the corporate staff.

Philip C. Wright has been appointed engineering program manager for Motorola's B-70 bomber electronics subcontract.

William B. Gross becomes vice-president of engineering at Performance Measurements Co.

Gordon A. Carlson has been appointed executive vice-president of Hofman Laboratories, Inc., Hillside, N.J.

North Atlantic Industries, Inc., Westbury, N.Y., has appointed **Jack Bair** as chief mechanical design engineer and **Arthur Frielich** as staff engineer. **Leon Sternick** has joined the company as staff assistant to the chief engineer.

Robert W. Pollock is the new chief of technical liaison of CTL, Cincinnati.

Murray J. Charet has joined the Aircraft Equipment Div. of Consolidated Diesel Electric Corp. as a project engineer.

Robert L. Adams has been named general manager of the recently formed Mallory Electronics Div., P. R. Mallory Co.

Hugh C. Bream has been named vice-president and manager for the Santa Barbara operation of Western Design Div., U. S. Industries; **Ben J. Newitt,** Western Design controller, will serve in the additional post of executive assistant to the division president.

William G. Hoover, professor of electrical engineering at Stanford Univ., has been appointed technical director of Granger Associates.

Gurdon M. Butler Jr. has been appointed director of research for Gladding, McBean & Co.

Carl Pilnick has been elected vice-president and director of R&D at Consolidated Avionics Corp.

Hallamore Electronics Div., Siegler Corp., has announced the appointment of **Walter J. Kruel** as executive vice-president.

John F. Biehle has been appointed technical director of the Beryllium Components Div. of Astrometals Corp., Hawthorne, N.J.

HONORS

Col. John P. Stapp, 1959 president of the AMERICAN ROCKET SOCIETY, has been elected a Fellow of the American Astronautical Society. The award is bestowed upon those persons "who have made a direct and significant contribution to the field of astronautics."

The Timoshenko Medal for distinguished contributions to the science of applied mechanics has been awarded to **Sir Richard V. Southwell,** former rector of the Imperial College, London, and an authority on elasticity, strength of materials, and hydrodynamics.

Alvin N. Hammer, metallurgist in Convair's quality control process laboratory, has been awarded the seventh annual Coolidge Award, a bronze plaque presented by General Electric for the year's outstanding scientific reporting on nondestructive testing.

The Nuclear Div. of Martin-Baltimore has awarded $1000 to two of its engineers, **Harold N. Barr** and **Donald H. Peterson,** for their work in solving abrasion problems in an advanced nuclear reactor system under development. ♦♦

A Space Scout In Preparation

Photo shows the multistage solid-propellant research rocket Scout being put through structural test with its launcher at Chance Vought Aircraft, which is integrating vehicles for NASA under a million-dollar contract. A launcher has now been installed at NASA's Wallops Isand, Va., station. Scout will be able to put a 150-lb satellite in a 300-mile orbit or to boost a 100-lb probe to an altitude of 5000 miles and more.

From the patent office

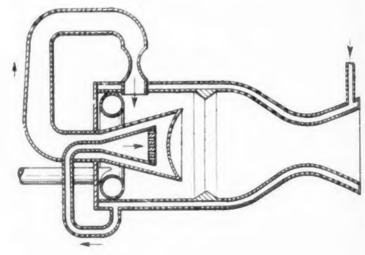
By George F. McLaughlin

Fuel Mixing System Increases Combustion Efficiency

The accompanying diagram shows the patented device, a liquid rocket motor, that aims to increase combustion efficiency.

In motor operation, oxidizer is supplied through an inlet to the space between the casing and jacket; flows to the opposite end of the motor through an outlet and pipe to a spray head; and then passes through ports into the interior of the heat exchanger in which it is vaporized. Vapor passes through a venturi and nozzle into the mixing chamber. Fuel is supplied to the manifold and issues into the chamber, and the vapor and liquid are given a swirling motion around the exchanger. If the fuel being used is not spontaneously inflammable with the oxidizer, it may be ignited with an igniter. Combustion is completed in the main combustion chamber.

The wall of the casing is cooled by the oxidizer. The heat exchanger is also cooled by the oxidizer sprayed against the head through the ports. The concave surface of the heat-exchanger head deflects gases in the main combustion chamber outwardly and directs them into the stream of gas from the mixing chamber to the combustion chamber.



Sectional view showing internal arrangement of Coty rocket motor.

The combustion system was designed so that various propellants may be used. Oxidizers may be red or white fuming nitric acid, and fuels may be gasoline, kerosene, or other low boiling petroleum. Other oxidizers such as concentrated hydrogen peroxide or liquid oxygen may be used, and fuels such as alcohol, aniline, and hydrazine may also be employed. Propellants are mixed prior to their passage to the main combustion chamber.

Metal parts are of stainless steel or titanium. A lining in all or part of the mixing chamber, combustion chamber, and nozzle may be formed of silicon carbide, graphite, and zirconium oxide.

It is possible, if desired, to use pulverized solid fuel instead of liquid, thereby widening the field of utility of the motor.

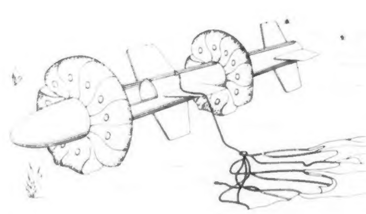
Patent No. 2,887,844. Rocket Motor. Fred P. Coty, Niagara Falls, N.Y.

Recoverable Guided Missile for Tactical Training and for Testing Components

Electronic equipment designed to simulate missile maneuvers for training purposes has many drawbacks, among them high cost and the inherent inability to simulate nonlinear dynamic functions of airborne missiles.

A patent has been granted for an invention providing guided-missile-countermeasures training capability. It permits a realistic and empirical evaluation of ground control, ground test, checkout, and calibration equipment. The invention provides a missile having an average over-all firing cost considerably less than that of a conventional tactical missile.

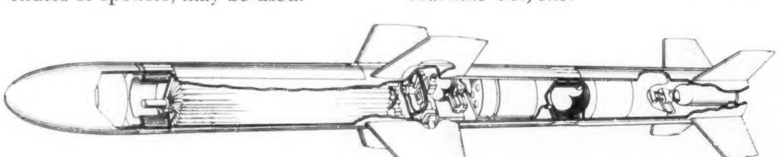
The nature of this missile can be seen from the illustrations here. When the missile falls to earth, a buffer and flotation device reduces impact loads. The device contains a flexible membrane which is inflated by air or gas after hatch covers are automatically released from the airframe. Another cover jettisons to release a parachute. When the missile falls to earth, its speed is reduced by the parachute, and initial impact is lessened by the buffer and flotation gear. Instead of (or in addition to) a parachute, other aerodynamic drag means, such as rotochutes or spoilers, may be used.



Training and test vehicle ready for recovery on land. Buffer and flotation devices also permit recovery from a body of water.

In this manner the missile may be recovered from the ground or body of water with minimum damage. Therefore, the operation of all or specific components may be evaluated after an operational flight. Also, malfunctions can be readily isolated and analyzed.

Patent No. 2,887,055. Training and Test Missile. Michael P. Bogdanovich, San Pedro, and James R. Wilson, Glendale, Calif., assignors to Harvey Machine Co., Inc.



Isometric view of airborne training and test vehicle designed to permit installing various internal mechanisms.

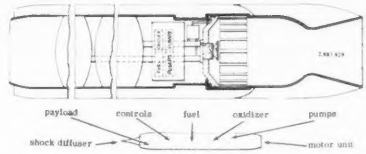
NASA Asks Patent Flexibility

NASA officials, appearing before the House space committee, have urged Congress to make it possible to release patents on inventions made under government contract. The government now takes title to such patents, except in defense programs.

Rocket Engine Convertible For Ramjet Operation

The same motor or combustion chamber used for either rocket or ramjet operation, with the same fuel-injection apparatus used for either propulsion mode, is envisaged by this patent. An oxidizer supply and injection system is provided for use during operation of the motor as a rocket. Ram-air ducts and air-entrance openings allow operation of the motor as a ramjet. During rocket operation, a valve closes the air-entrance openings.

When the invention is used to propel a missile, rocket propulsion would be used at a high thrust value for a short interval to accelerate the missile to a desired altitude and speed. With rocket oxidizer substantially spent, oxidizer flow would be reduced, the ram-air valve actuated, and the motor operated as a ramjet. Rocket thrust for acceleration would be of the order of 5 to 10 times the thrust required for sustained flight.



Longitudinal Section of Ramjet-to-Rocket System.

A vehicle utilizing the invention can be designed for a variety of performance characteristics. Generally, it is adaptable to medium- and long-range ground-to-ground missiles operating at altitudes of 40,000 to 60,000 ft and at speeds of Mach 1 to 3. The invention can also be used for piloted aircraft.

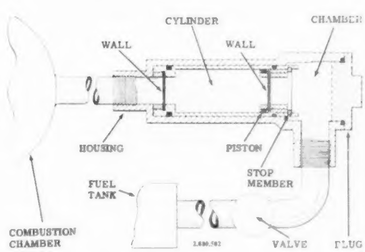
Patent No. 2,883,829. Rocket Engine Convertible to a Ramjet Engine. Alfred Africano (Member, ARS), Caldwell, N.J.

Fuel Cartridge Starts Rocket Engine

One means of starting a rocket engine is by first supplying a starting fuel to the combustion chamber and then following this with the operating fuel after ignition. In such a system it is difficult to ascertain the quantity and distribution of the starting fuel in lines before firing. Another problem is that operating fuel may mix with starting fuel before the latter has entered the injector head. This can result in insufficient starting fuel at first, accumulation of mixed fuel in the rocket chamber, and possibly a destructively explosive start.

The invention solves these problems by insuring that a fixed quantity of starting fuel is supplied to the combustion chamber before release of the operating fuel. The accompanying drawing illustrates the system. A cylinder, or cartridge, containing the starting fuel is placed within the housing. The cylinder is not filled completely as there must be space for thermal expansion of the starting fuel.

To start the engine, a valve is opened to permit the flow of operating fuel to the chamber before the cartridge. Pressure in this chamber moves a piston and a rupturable wall to one side, compressing the starting fuel. As the piston and rupturable wall continue to move, pressure in the cylinder increases. At a predetermined pressure, one wall member ruptures, and the starting fuel flows



Fuel-cartridge starting system.

to the combustion chamber and ignites upon contact with the oxidizer.

As soon as the starting fuel is pushed out of the cylinder, the piston moves until it reaches a stop in the cylinder. When the piston stops, pressure of the operating fuel ruptures the other wall member and operating fuel follows directly behind the slug of starting fuel into the combustion chamber.

The invention reduces starting fuel maintenance and handling costs. For example, the extent to which the starting unit is filled can be ascertained visually when it is loaded. Also, the starting unit can be filled and stored indefinitely until ready for use.

Starting Assembly for a Power Plant (2,880,582). Clement J. Turansky and Sylvester J. Pirrone, Buffalo, N.Y., assignor to the U.S. Air Force. ♦♦

Missile Market

(CONTINUED FROM PAGE 76)

perience has taught them this frothy action whips up a huge bubble which must burst one day. Unfortunately, no one knows when that day will be; as Wall Street expresses it, "Nobody ever rings a bell." Extreme caution must be exercised, particularly toward low-priced securities.

In summary, good business and a strong stock market should mark the next 6 months. The peculiar problems of the missile industry make it increasingly difficult to invest on a sound basis. Even informed speculation is now considerably riskier. Selectivity, which has been so prominent in past months, is still the byword. Hence, future columns will endeavor to point out selected stocks that offer attractive investment opportunities. ♦♦

Thiokol-Navy Show Prepackaged Liquid Rocket Production

Thiokol and the Navy recently showed a product of two decades of liquid-rocket development—liquid-rocket engines that can be assembled and loaded with propellants at the factory. These engines, Guardian's I and II, will power the Navy's all-weather air-to-air Sparrow III and air-to-ground Bullpup missiles, respectively.

The inspection took place at Thiokol's Hunter-Bristol Div., where the motor metal parts are machined, assembled, and loaded. Production of Guardian I began in Dec. 1958, of Guardian II in Aug. 1959.

The new liquid engines match the ballistic properties of the previous solid engines. The Navy went to liquids in this instance because they offered higher temperature limits than the solid motor designs. That is, the solid motors could not take the aerodynamic heating incurred at the high flight speeds of new Navy aircraft. The liquids also offered much longer shelf life than the solids, possibly as long as 5 years according to the Navy.

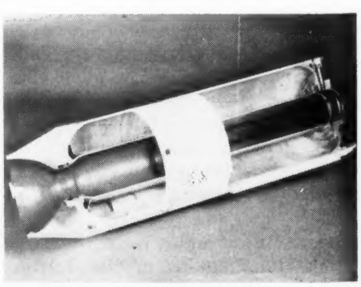
The Guardian design is a variety of the hybrid engine, which is discussed by Douglas Ordahl in the October 1959 *Astronautics*. An axial solid-propellant gas generator, which can be seen in the accompanying photo, pressurizes propellant tanks butted end to end. The propellants and the gas generator exhaust flow through the portion of the motor covered in the photo into the combustion chamber, which extends well up into the motor. Fuel in the aft tank flows over the combustion chamber wall, cooling it.

The motors are constructed largely of weldable aluminum alloys. Heliarc welds form most of the closures. The nozzle is ceramic-sprayed copper. The design employs about 60 parts in all.

Notice that although the liquids have long shelf-life the solid grain may not. Progress has been made, however, in the storage properties of certain solid propellants, and these motors have provision to remove and replace the gas-generator grain.

Thiokol has scaled up the general design presented by the Guardian series to about 50,000 lb thrust. This would not be bad thrust for a number of applications, such as an air-launched ballistic missile. It remains to be seen, however, whether this general design can compete with other rocket developments in such things as mass ratio.

The idea for a preloaded liquid-propellant rocket pressurized by a solid-propellant charge can be traced to German work on the Taifun missile in WW II. The Navy continued the German work at the U.S. Naval Ordnance Test Station after the war. Reaction Motors took interest in the packaged idea early in the 1950's, and the present Guardian motors are outgrowths of joint Navy-RM development work.



Partial cutaway view of Guardian II motor for Bullpup missile. The remaining motor section masks an evidently classified injection area.

Astro Notes

(CONTINUED FROM PAGE 12)

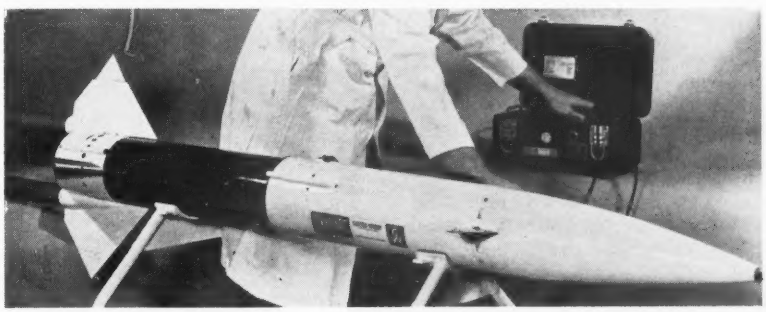
Emerson Electric's Thermo-lag sublimating paint on Little Joe test capsules in the Mercury program; the material can be used for temperature control by variation of both its thickness and composition . . . Raytheon's "pyrographite" development has produced a good one. The highly pure, heat-treated, and compacted form of graphite, which withstands temperatures up to 6700 F, shows promising applications as a heat-shielding material; it has extremely high surface conductivity and is impermeable to gases. . . Tungsten coated directly on graphite nozzles with a plasma-arc torch shows excellent performance without the aid of an undercoat to increase bonding strength, according to the Linde Co. Much cheaper than rhenium or tantalum, which were also tested as nozzle coatings by Linde, tungsten coatings can be used for current operating conditions of 5500-F flame temperature and chamber pressures of 500 to 1000 psi in solid motors, including those with aluminized propellants. The company is now working on coatings that have melting points of about 7000 F for use at operating conditions of 6500-F flame temperature and chamber pressure as high as 2000 psi.

• In the line of more standard materials, United States Steel reports that its Airsteel X-200 gives fabricators a weldable alloy which can be air-quenched to develop a tensile strength of 280,000 psi.

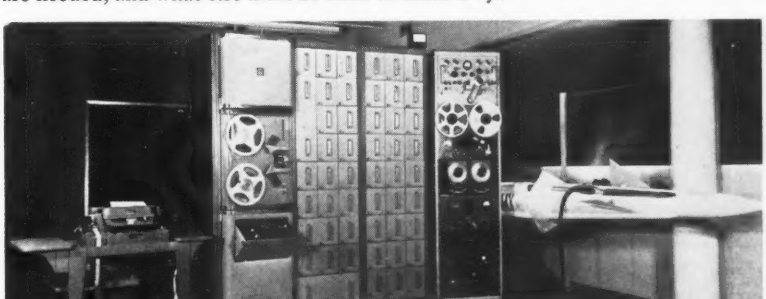
• Techniques for squeezing high performance out of cheap, low-alloy steel also offer rocket engineers latitude for design. Republic Aviation has fabricated such steels into an overlapping-ring structure joined by adhesive and tempered to give a yield strength over 250,000 psi, a performance 30 per cent better than the general one-piece welded construction in use on motor cases. The company also sees techniques for permanent joining of dissimilar metals, such as steel and titanium, bringing weight savings of 30 per cent in some rocket cases, as well as reducing their cost.

• A new infrared detector based on a copper-doped germanium crystal has been developed by Hughes' Santa Barbara Research Center for long-distance tracking of satellites and missiles. The device is very sensitive in the 8- to 25-micron range. ♦♦

Skydart and Demon Shown by Curtiss-Wright



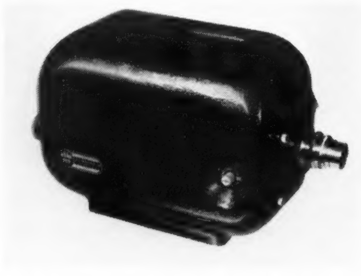
At a recent open house, Curtiss-Wright's Santa Barbara Div. in sunny California showed two of its new developments, the Skydart I (above), a Mach 0.8 expendable rocket-powered target for testing Sidewinder at high altitudes, and Demon (below), an automatic universal checkout system for missiles and satellites. The Demon system, linked with missile or satellite for prelaunch checking, tells instantly what part of the bird is not operating, what spare parts are needed, and what else must be done to make it fly.



New equipment and processes

Aerial Reconnaissance Camera: Especially adapted for drones and light aircraft, the KA-30 camera, with film 5 in. wide, fits into spaces occupied by older cameras providing photographs only one-fourth the picture area. It can be operated either manually or automatically in manned or unmanned aircraft under virtually all light conditions. The KA-30 may be fitted into automatic camera control systems. Chicago Aerial Industries, 1980 Hawthorne Ave., Melrose Park, Ill.

High-Speed 16-MM Camera: Developed for motion-picture taking under extreme environmental conditions, the Model DBM-5 camera produces steady pictures for airborne, rocket-sled, and static-test applications. It features



start/stop operations up to 400 fr/sec. Characteristics include dynamically balanced, intermittent film transport, daylight loading, quick-change shutters, and 400-ft film capacity. D. B. Milliken Co., 131 N. Fifth Ave., Arcadia, Calif.

Missile Siren: Suitable for missiles or other installations requiring miniaturized warning devices, the Model S-3 is less than 2 in. in diam. The unit, powered by a 115-v AC, 400-cycle motor, produces a tone of 1100 cps at 80 db and 11,000 rpm. Electro Products Div., Western Gear Corp., 132 W. Colorado Blvd., Pasadena, Calif.

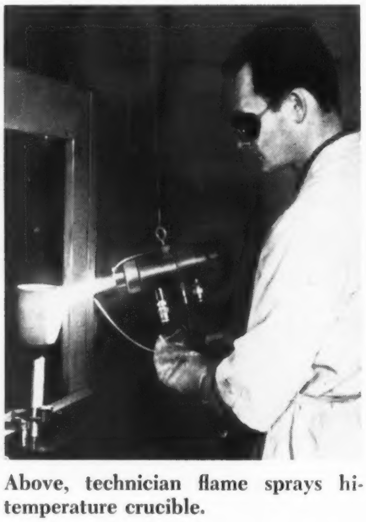
Hand-Fed Power Threader: For tapping holes, cutting external threads, and other common drill-press operations in metal or plastics, the Sensi-Threader performs a variety of other operations that benefit by delicate handwork. With simple holding fixtures on the workplate, castings, stampings, moldings, and machined pieces can be threaded on a production basis. Operating speed is 700 rpm. Sensi-Threader Sales Co., 4820 –49th Ave., S. W., Seattle 16, Wash.

Universal Flexure Pivots: Smallsize flexures used in high-precision calibration systems and thrust stands, rocket-motor test programs, weighing systems, fatigue machines, and other measuring systems are supplied in a wide range of load capacities. They are available as completely universal, two-direction, or single-direction pivots. A 200,000-lb-capacity unit occupies a space less than 14 cu in. Aeroscience, Inc., 3155 N. Rosemead Blvd., Rosemead, Calif.

Miniaturized Fan: Powered by a 28-v DC motor, the Model F2-17 fan produces 45 cfm of air at 1700 rpm. It is designed for electronic or avionic applications. The unit measures less than 2 in. in diam and is 2 in. long. Electro Products Div., Western Gear Corp., 132 W. Colorado Blvd., Pasadena, Calif.

Plasma Spray Gun Developed by Metco

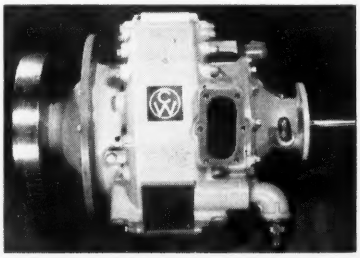
A plasma spray gun that applies coatings of any material which can be melted without decomposing, has a wide range of operating temperatures, and produces coating temperatures 98 per cent of theoretical has been developed by Metallizing Engineering Co., Inc. (Metco), of Westbury, N.Y. The gun (Type MB) utilizes an electric arc and inert polyatomic gases to produce flame temperatures up to 30,000 F, although 10,000 to 15,000 F are ample for flame spraying. Among advantages of the Type MB flame spray gun, Metco cites reduced porosity, improved bond and tensile strengths, and less oxide content in the case of metal and high density.



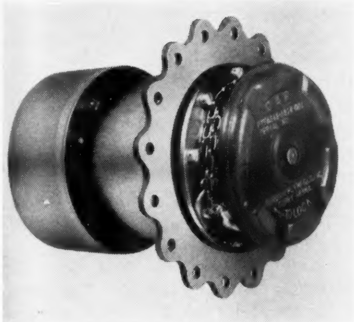
Above, technician flame sprays hi-temperature crucible.

Curtiss-Wright Unveils New Engine

Curtiss-Wright recently revealed that it has developed, in cooperation with NSU Werke of West Germany, an internal combustion engine with these features: (1) two moving parts, a rotor (trochoid principle, with three arced sides moving eccentrically in a four-sided, cavitated chamber) and a straight crankshaft, (2) three power sequences to the crankshaft per revolution of rotor, in an almost continuous combustion cycle, (3) low vibration and noise, (4) operation on automobile gasoline at fuel consumption of 0.45 or lower, (5) no hot spots and about 250 F operating temperature, (6) ignition by an automotive carburetor, and (7) construction in gray iron at about a pound per hp or in aluminum at about a half-pound per hp. The company plans to produce models of the engine ranging from 100 to 700 hp next year, and has in development models for the 750 to 5000 hp range. NSU Werke has developed low-hp units. The new engines are aimed at a wide commercial and military market.



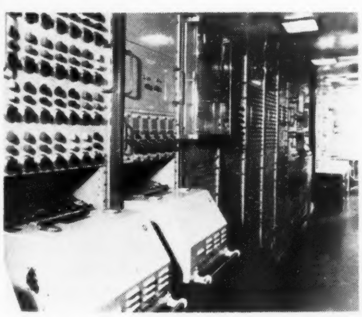
Above, a 100-hp version of the new Curtiss-Wright rotating combustion engine.



Remote Servo-Controlled Flow Valve: High-energy fuels and other liquids can be handled by refueling valve No. 42-1755-000 which is readily adaptable to unusual flow rates. Normally the valve is built to handle 200 gpm with an operating pressure of 50 psi. Operating temperature ranges from −65 to 160 F for fuel and ambient. The valve operates from a remote servo valve. Aero Supply Mfg. Co., Inc., Corry, Pa.

Air-Operated Pumps: Liquid pressures up to 50,000 psig at temperatures up to 500 F are developed by a new line of air-powered pumps. These pumps are useful for locations where electrical power is not available, or where such power is dangerous to use. Oil, water, and various chemical solutions may be pumped. Pumps are of duplex design; that is, one piston provides suction while the other delivers a high-pressure fluid. American Instrument Co., Inc., 8030 Georgia Ave., Silver Spring, Md.

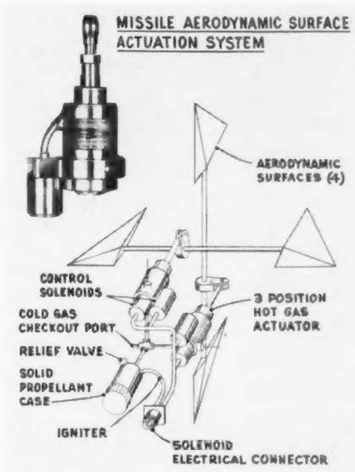
Data Reduction On the Road



This is the interior of a new mobile missile data reduction van developed by Consolidated Avionics for ABMA. Accepting up to 216 transducer outputs, the van system records data in both digital and analog form and then converts it to a form suitable for processing. It is equipped with tape and strip-chart recorders, direct-writing oscillographs, and visually read meters.

Liquid Level Sensor: This electronic unit senses the presence of liquids and any change from liquid to gas or vice versa. In addition to its use as a flow-control signal for missile ground support equipment, it can be used in test devices; as a component in fuel and oxidizer control systems to fill tanks and provide complete utilization of fuels and oxidizers in flight; and for stage separation of missiles when fuel has been completely used. Pioneer-Central Div., Bendix Aviation Corp., Davenport, Iowa.

Missile Actuation System: Aerodynamic surface controls can be actuated by a lightweight system designed for guided missiles. The system includes two 3-position actuators, solid propel-

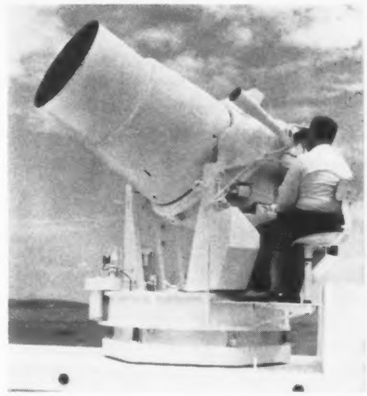


lant, and an igniter. Gear trains and levers are eliminated, since all actuation is obtained within actuators designed for various loads and travel. A system with 50 in.-lb surface force weighs 5 lb. Bendix Products Div., Bendix Aviation Corp., South Bend 20, Ind.

Fuel-Oxidizer Servicing Nozzle: Oxidants and fuels, except those requiring stoneware transmission, can be handled safely using a nozzle and adapter especially designed for fueling operations prior to countdown. For closed-

circuit fueling operations, two nozzles are required to transfer the liquid from the supply source to missile, and overflow venting from missile to sources. The equipment was originally designed to accommodate RFNA. Lear-Romec Div., Lear, Inc., Elyria, Ohio.

A Sharp Mount



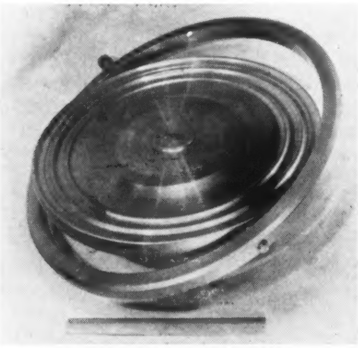
Precise machining of the mount for this Telecamera used at Aberdeen Proving Ground to track small missiles gives the instrument a rotational accuracy within ±2 sec of arc—better angular accuracy than offered by known cinetheodolites. The mount was produced for Army Ordnance by Steel Products Engineering Co., Div. of Kelsey Hayes, Springfield, Ohio.

Laboratory Test Set: Both swept and CW signals are provided in the Model 303 test set. The unit contains three oscillators, all operating in the 20 to

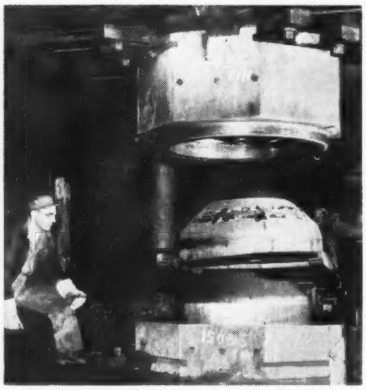
40 mc range. Output of the oscillator circuit is 1-v RMS into 50 ohms. Each output may be attenuated from 0 to 140 db in 1-db steps. Hermetically sealed, deposited carbon resistors are used to maintain an over-all accuracy of attenuation of better than 0.5 db. Telonic Industries, Inc., Beech Grove, Ind.

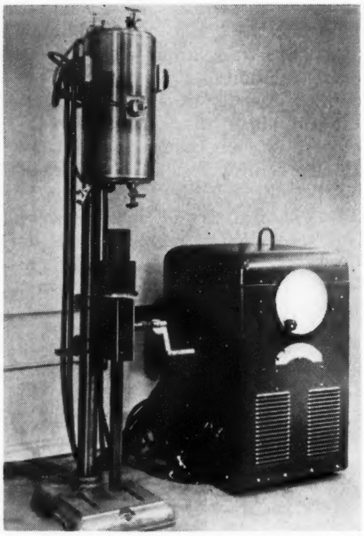
Space Metals Closed-Die Forged

Wyman-Gordon revealed two "firsts" in large closed-die forging of metals with potentially wide application in missiles and space vehicles at the ARS 14th Annual Meeting. One was the 35,000-ton-press forging of GE's Astroloy (guaranteed 0.2 per cent yield strength of 122,000 psi at 1400 F) as a 26-in. turbine wheel and integral ring weighing 170 lb. This was the first successful closed-die forging of Astroloy after 14 months of study by Wyman-Gordon. The other was the large-scale forging of all-beta titanium, shown here as a solid-rocket bulkhead coming off the 50,000-ton closed-die press at the Wyman-Gordon–Air Force plant at Grafton, Mass. The bulkhead has a maximum diam of 41.16 in. and weighs 441 lb. The all-beta alloy has a yield strength of 180,000 to 200,000 psi with 4 to 6 per cent elongation at room temperature. Although large shapes like the bulkhead have been made, the use of titanium in missiles such as the Pershing has evidently been deferred.



New Wyman-Gordon closed-die forgings: Above—26-in. diam, 170-lb turbine wheel and integral ring of GE's Astroloy; below—all-beta titanium alloy missile bulkhead, 41.16 in. in max. diam and weighing 441 lb, shown coming off 50,000-ton press.





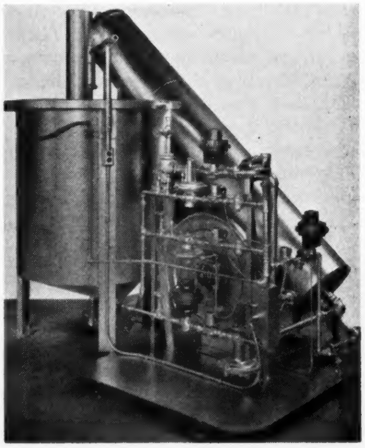
Furnace for Materials Research: Available with or without automatic temperature controls, the C-W resistance furnace for laboratory use operates to 5000 F. It uses an inert gas for interior atmosphere, with a graphite heating element and carbon insulation. The chamber is 4 in. in diam and 8 in. high. Size can be varied to meet specific requirements; power input is 15 kw. Curtiss-Wright Corp., Santa Barbara Div., P.O. Box 689, Santa Barbara, Calif.

Shock Tester: Hyge-6500 tester repeats either of a choice of two widely specified shock pulses in rapid succession. A complete test cycle can be performed every minute. Wide, bulky specimens can be accommodated on the $12^1/_2$ in. carriage. Acceleration level for the half-sine test is from 10 to 100 g. For the sawtooth test, the level is 25 to 100 g. Maximum specimen thrust is 15,000 lb. Consolidated Electrodynamics Corp., Rochester Div., Rochester 3, N.Y.

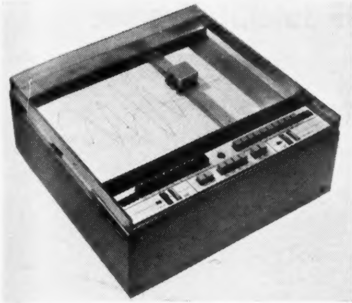
Condenser Microphone: Two microphone cartridges are available—Model 4131 with a flat freefield response from 20 to 18,000 cps, and Model 4132 with a flat pressure response conforming to the ASA Standard ZS24.8–1949 for L-type microphones. Cartridges are dimensionally interchangeable with the ASA standard microphone. B&K Instruments, Inc., 3044 W. 106 St., Cleveland 11, Ohio.

Protective Suit: Chemical treatment of the Model PS-KA-1 liquid-oxygen protective suit makes it electrically-static resistant and flameproof. Made of heavy nylon, the suit features open-vision faceplate, double-face plastic shield, and adjustable plastic headpiece. Sleeves fit snugly over 14-in., oil-free leather gloves. Alamo Specialty Co., 2810 Culebra Ave., San Antonio, Tex.

Gas-Fired Test Furnace: Thermocouple reliability at temperatures above 3000 F can be determined by a furnace originally developed for Marquardt Aircraft. The heating chamber is 6 in. in diam and 6 in. high, but the size can be varied. Refractories are of zirconium oxide. The unit features radiomatic temperature control and full safety controls. Hirt Combustion Engineers, 1633 Bluff Rd., Montebello, Calif.



Vibration Interferometer: Designed for extremely precise checking and calibration of accelerometers used for vibration tests, a new instrument has a frequency range of 450 to 10,000 cycles. The equipment consists of three major components—the interferometer, multibeam stroboscopic slit assembly with white light source, and a vibrator. Double amplitudes over a range of 1 to 1000 micro-inches can be determined to an accuracy of 10^{-6} in. Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.



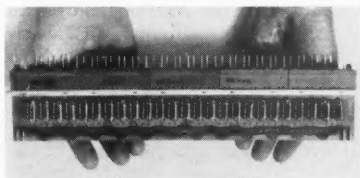
X-Y Plotter: Vernier scale ranges are featured in pushbutton-operated plotter, the Model 210. A flat vacuum-platen and provision for precision positioning facilitates paper alignment and loading. The plotter has a static accuracy of ±0.10 per cent of full scale and a dynamic accuracy of ±0.20 per cent of full scale at 10-ips tracing speed. Tracing action of the pin is splatterproof. Librascope Inc., Glendale, Calif.

Overload Circuit Breaker: Fast high voltage overcurrent protection is provided by a circuit breaker available with voltage and current ratings up to 115 kv and 4000-amp interrupting capability. Positive interruption at first current zero in AC circuits limits arc time to less than 8 millisec. The circuit breaker is composed of a vacuum switch mounted as a normally open "fail safe" relay actuated by a 115-v DC solenoid. Jennings Radio Mfg. Corp., P.O. Box 1278, San Jose, Calif.

Packaged Universal Tester: Hundreds of standard cyclic tests for electrical and electromechanical apparatus can be performed with a packaged tester weighing 22 lb. The instrument performs repetitive test functions, such as life testing, duty cycle tests, temperature rise, or load tests. Heavy-duty, 20-amp connecting plugs accommodate two independent test circuits. A wiring diagram with instructions and ratings is provided on the rear panel. Automatic Timing and Controls, King of Prussia, Pa.

Band-Pass Filter: Two or more radar systems are permitted to operate in the same band with a minimum of interaction by use of the Antran filter. The unit provides preselectivity to receivers, making them sensitive only to a narrow bandwidth. It attenuates undesirable signals, and filters out unwanted radiation and spurious energy, including subharmonics and harmonics for a specific application. Range of frequencies is from 200 to 10,000 mc. Antran, Div. of International Electronics Mfg. Co., 1000 Connecticut Ave. N.W., Washington 6, D.C.

Computing and Memory Device: Called the Paramistor, this magnetic logical computing and memory device is a versatile module composed essentially of 25 bi-stable elements capable of self-limiting amplification. It operates on AC-phase relationships rather than DC pulses. Parametric excitation of ferrite resonators causes oscillation in either of two phases (180-deg opposed) providing bi-stable characteristics. The device was developed at Tokyo Univ. Kanematsu, New York, Inc., 150 Broadway, New York 38, N.Y.



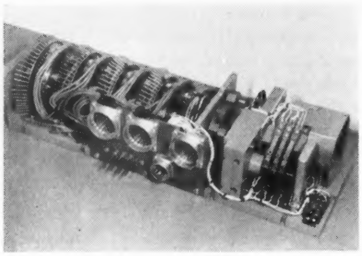
Waveguide Quick Disconnect: Adaptable for use on all types of waveguide components, Model 3419 Disconnect is attached to a standard choke flange with two screws. The coupler is made in two sizes, one for K-band and one for X-band. A slight CW rotation of the coupler quickly and securely fastens the two pieces of the waveguide together. Aircraft Armaments, Inc., Cockeysville, Md.

Thermocouple Wire: Used where thermocouple leads must pass through zones of extreme heat and yet accurately measure high temperatures, MgO-insulated metal-sheathed thermocouple wires withstand ambient temperatures of 2000 F. Insulation is crystalline magnesium oxide compacted to maximum density inside the sheath. Iconel sheaths are impervious to moisture, oil, petroleum, ozone, and solvents. Revere Corp. of America, Wallingford, Conn.

Miniature Packaged Controls: Power supplies and other components are self-contained in a new line of packaged controls available in round or rectangular models. Either AC or DC meter-relays may be specified. MIL-type components are used where applicable. Round models have 2-in. barrels ranging in length from 2 to 5 in. Rectangular models use VHS non-indicating meter-relays, and measure 2 in. by $2^{1}/_{4}$ by $2^{3}/_{4}$ in. Relays in some new models limited to maximum loading of 2 amp. Assembly Products, Inc., Chesterland, Ohio.

Springwound Gyro: This springwound, split-rotor gyro with solid-bar inner gimbal keeps wound indefinitely and rewinds for repeated use, with no loss of accuracy. It resists shocks of 100 g, acceleration of 30 g, and vibration at 10 g while maintaining drift accuracy of 0.1 deg/sec. Optimum-performance running time is 4 min.; rundown time, 8 min. It offers a choice of resistive, commutator, or selsyn pickoffs. Clary Dynamics, 408 Junipero St., San Gabriel, Calif.

Cooler for Infrared Detector: Infrared detection equipment may be cooled to 60 K (−350 F) by the 8-oz min-IR-cooler. The closed-cycle system weighs less than 20 lb, and further development is expected to reduce this weight to 10 lb. In operation, helium gas expands from 300 psi in a cylinder 0.25 in. in diam and 2 in. long to run cooling cycle. A plastic piston is the only moving part below room temperature. Arthur D. Little, Inc., Acorn Park, Cambridge 40, Mass.



Scanner Handles up to 160 Individual Pressures: Although designed for wind-tunnel applications, in which up to 10 pressures can be scanned by each of 16 transducers of a 16-channel system, the SP-105 pressure scanner can be used in any pressure instrumentation system. The unit consists of four rotors, four stators, a motor, switching mechanisms, and electrical and pressure connections. Each rotor has provision for mounting four flush diaphragm transducers. The stators have 40 pressure-line outputs each. The scanner is designed for pressures from 0 to 100 psia on the pressure inputs, from 14 to 100 psia on the reference pressure lines, and from 0 to 75 psia on the vent lines. A 115-V, 400-cycle AC powers the scanner's $^1/_{10}$ hp motor. Dimensions of the instrument are 20 x 6 x 4 in. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Differential Pressure Transducers: Two electromechanical sensing devices, Types PDH-4 and PDH-4C transducers, made in seven pressure ranges from 0 to 50 and 0–5000 psi, and in gage and differential types, embody the accuracies essential in sensing and transmitting proportional AC voltage to readout equipment and servo controls with missiles and aircraft. Location of parts provides for fittings at 60, 120, and 180 deg. Crescent Engineering & Research Co., N. Peck Rd., El Monte, Calif.

High Gas Temperature Probe: Where cooling of the probe is not practical, Probe T-1006-2 is particularly suited for missile or flight applications. The noncooled probe measures total temperature in an afterburning turbojet or ramjet engine. Parts are coated with molybdenum disilicide to prevent oxidation with an operating temperature of 3100 F in still air and 2900 F in moving air. The time constant is faster than 0.8 sec. Aero Research Instrument Co., 315 N. Aberdeen St., Chicago 7, Ill.

Strain-Gage Pressure Pickup: Accuracy at pressure to 10,000 psia or sealed gage is retained in a chamber-type unbonded pressure pickup (Type 4-326). It has provisions for adjustment of bridge balance, temperature compensation, and sensitivity in a chamber isolated from the sensing element. Combined effects of linearity and hysteresis are less than ± 0.5 per

IR Satellite Tracker

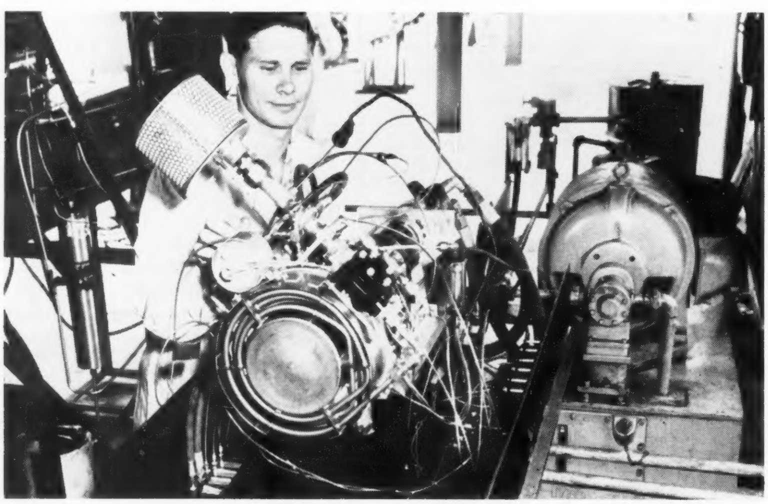
Developed for AFCRC by ITT Laboratories—San Fernando, this tracker picks up satellite-radiated IR with a 19-in. concave mirror that focuses on a measuring cell. The cell reads out to the oscilloscope and recorder in foreground. The mirror oscillates to scan the suspected region of satellite passage, and semiautomatically follows the satellite once it is detected.

cent of full range output, as measured from the best straight line through calibration points. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Electric Thermometer: Untrained personnel can operate this instrument, which can be set for any of 12 ranges in a total range of −425 to 800 F and

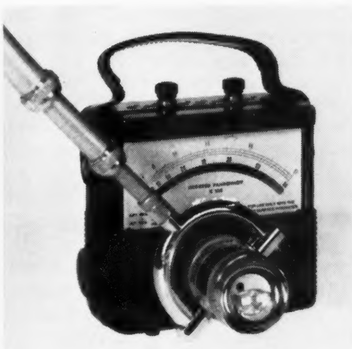
gives readings directly in degrees F with $^1/_2$ deg accuracy over most of the total range. It runs off a self-contained C-battery or a 60-cycle 110-v AC source. A number of probes can be linked with the thermometer and read alternately. Weight, 12 lb. Trans-Sonics Inc., Burlington, Mass.

Lightweight High-Output Compressor



The Western Branch of the Stratos Div. of Fairchild Engine & Aircraft Corp. is developing a lightweight, high-output compressor as part of the ground system for the Army's Pershing missile. Said to provide the highest output per size and weight of any such equipment available, the compressor is designed to weigh about 30 lb and deliver 12 cu ft of air per min at a pressure of 3000 psi at sea level. Its casing will be only 18 in. in diam and 12 in. long. A four-stage unit, it is designed in a 90-deg V-shape, and can be adapted to either electric or hydraulic drive. Stratos Div.—Western Branch, 1800 Rosecrans Blvd., Manhattan Beach, Calif.

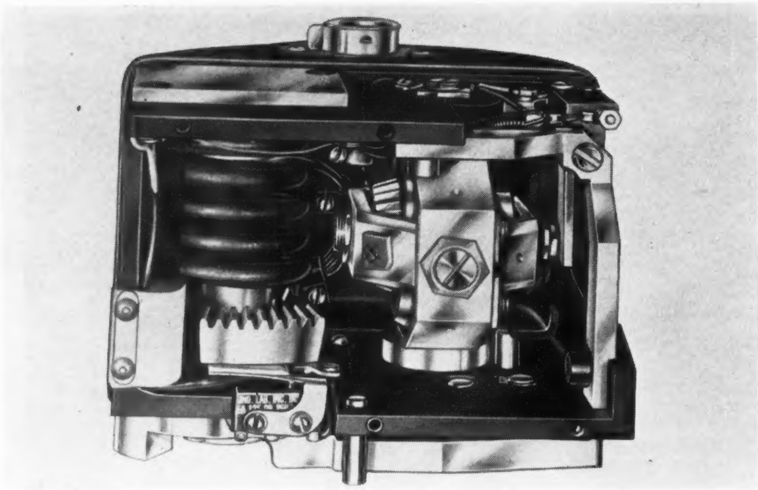
Surface Pyrometer: Basically a radiation pyrometer, the Type SP, because of its operating principle, requires no emissivity corrections on most applications. It reads directly the temperature of surfaces (except bright metals) to an accuracy of $\pm\ ^3/_4$ per cent. The measuring range of the head is 200 to 2400 F. Auxiliary indicating and recording instruments are available. Atlantic Pyrometers, Inc., 190 Warburton Ave., Hawthorne, N.J.



Gravity Sensing Potentiometer: Built to provide operation dependent upon the motion of an air bubble in a curved glass tube, the EP 1012 potentiometer gives an error signal with small deviation from the horizontal. Three electrodes are sealed in the tube which is partially filled with an electrolytic solution. When the unit is horizontal, the resistance from the two electrodes to the common electrode is equal. Hamlin, Ind., 1316 Sherman Ave., Evanston, Ill.

Phenomena Recorder: X-Y recording of phenomena far beyond the limits of electromechanical plotters is possible with a recorder which uses optical galvanometers, an ultraviolet light beam trace, and immediate-developing direct printpaper charts. The high writing speed of the Model 670 recorder permits fast, accurate recording of families of transistor curves or of rapid mechanical displacement, velocity, and acceleration. Traces are made on 8 x 8 in. charts. Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.

Direct Current Voltmeter: Model 0181 DC potentiometric voltmeter has a range from 0 to 10-v DC on either polarity with an accuracy of ± 0.025 per cent plus 3 microvolts. The unit has a readout facility of six decade switch dials having a resolution of ± 10 microvolts. Designed to be used as a portable set or a rackmounted installation, it is particularly adapted to transducer calibration. The Siegler Corp., Hallamore Div., Los Angeles, Calif.



Low-Cost Gyro

A two-degree-of-freedom gyro whose rotor is energized in a fraction of a second by a wound helical spring is now being offered by Waltham Precision Instrument Co., 221 Crescent St., Waltham 54, Mass. Providing guidance for a period of several minutes, and applicable for short-range missiles and target drones, the instrument can be made in production quantities for less than $200.

The spin axis of the unit is along the pitch axis of the missile, the outer gimbal along the roll axis and the inner gimbal along the yaw axis. A potentiometer pickoff about the other gimbal axis indicates the angle of roll. For short-duration flights, no erection system is necessary.

In operation, the WG-14 gyro is caged before takeoff or launching. The starting signal releases the wound spring which energizes the rotor. When the rotor is up to speed, the gyro uncages and acts as a free gyro in flight. Effective angular momentum is maintained for a period of 3 min after firing and drift rate controlled at less than 1 deg per min.

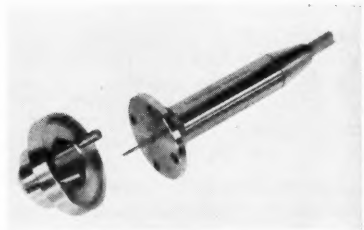
Temperature Control for Fluid Systems: Continuous, automatic, precision temperature control in both liquid and air baths is provided by a new transistorized system. It permits unattended operation for days, if necessary, and eliminates the need for personal attention in controlling temperature. The system can be applied in any situation where a mercury thermometer can be used as the primary sensing element. Temperature range is −38 to 340 C. Milltown Instrument Co., Milltown, N.J.

Gamma Irradiator: Heart of the high-intensity Radcell is a cylindrical irradiation chamber 2.5 in. in diam and 9 in. deep. The 44 cu in. capacity provides for irradiation of solid or liquid samples. Average dose rate is 200,000 r/hr or more throughout the chamber and fluid sample coil. A layer of thermal insulation surrounds the coils, outside of which 9 in. of lead shielding and steel cladding are located. Dimensions are 24 x 36 x 78 in. Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Special Thermocouples: Three types of thermocouples for immersion, heat-transfer, and surface-temperature measurements for missile and rocket engine application are available in temperature ranges of −350 to 2000 F. Location of the thermocouple junction in the heat-transfer thermocouple is controlled within ± 0.001 in. of a fixed distance from the surface. Plug, screw, and flat-mounted types have the thermocouple junction at the surface. Average response time of the immersion thermocouple is better than 250 millisec. Astra Technical Instrument Corp., 1132 Mission St., S. Pasadena, Calif.

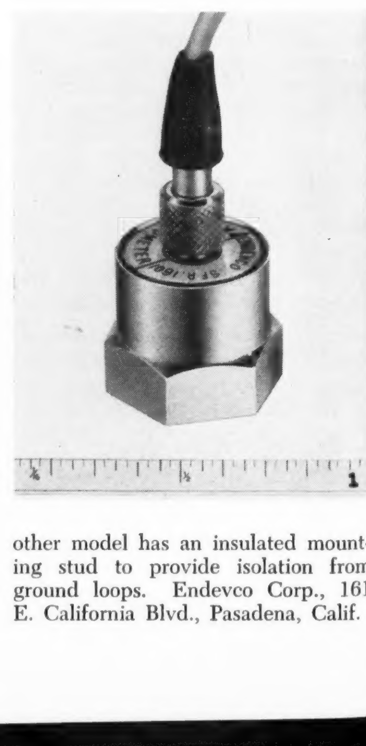
Oil-Damped Transducer: Miniature pressure transducer P2-85TC, for use in rocket-engine test environments, is designed to withstand the violent pressure transients generated in shock tubes or transmitted from firing chambers. The unit measures from 0 to 50 and 0 to 1000 psi; it weighs 3 oz. Output, 28 millivolts full-scale open circuit at 7 v (AC or DC) excitation; nonlinearity and hysteresis, not more than 1 per cent of full scale. Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Linear-Displacement Transducers: Model 580 and 581 transducers are complete units ready for connection to the required preamplifier and input source. They include differential transformers, are encased in stainless steel shields, and have carbide-tipped, spring-return contact rods and 10-ft integral cable and adapters. Both models have a maximum stroke of ± 0.050 in. (0.100 in. total), and



operate from 5-v, 2400 cps excitation. Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.

Subminiature Accelerometers: The Model 2224 and 2980 accelerometers are designed for applications where space is limited. Model 2224, 1/2 in. high and weighing 9 grams, provides 5 pk-mv/pk-g sensitivity with a first resonant frequency of 30 kc. The



other model has an insulated mounting stud to provide isolation from ground loops. Endevco Corp., 161 E. California Blvd., Pasadena, Calif.

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